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GENETICS[1]

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THE invitation to preside over the agricultural sub-section on this occasion naturally gave me great pleasure, but after accepting it I have felt embarrassment in a considerable degree. The motto of the great society which has been responsible for so much progress in agricultural affairs in this country very clearly expresses the subject of our deliberations in the words "Practise with Science," and to be competent to address you, a man should be well conversant with both. But even if agriculture is allowed to include horticulture, as may perhaps be generally conceded, I am sadly conscious that my special qualifications are much weaker than you have a right to demand of a president.

The aspects of agriculture from which it offers hopeful lines for scientific attack are, in the main, three: Physiological, pathological and genetic. All are closely interrelated, and for successful dealing with the problems of any one of these departments of research, knowledge of the results attained in the others is now almost indispensable. I myself can claim personal acquaintance with the third or genetic group alone, and therefore in considering how science is to be applied to the practical operations of agriculture, I must necessarily choose it as the more special subject of this address. I know very well that wider experience of those other branches of agricultural science or practical agriculture would give to my remarks a weight to which they can not now pretend.

Before, however, proceeding to these topics of special consideration, I have thought it not unfitting to say something of a more general nature as to the scope of an applied science, such as that to which we here are devoted. We are witnessing a very remarkable outburst of activity in the promotion of science in its application to agriculture.

[1] Address to the Agricultural Sub-section of the British Association for the Advancement of Science.

Public bodies distributed throughout this country and our possessions are organizing various enterprises with that object. Agricultural research is now everywhere admitted a proper subject for university support and direction.

With the institution of the development grant a national subsidy is provided on a considerable scale in England for the first time.

At such a moment the scope of this applied science and the conditions under which it may most successfully be advanced are prominent matters of consideration in the minds of most of us. We hope great things from these new ventures. We are, however, by no means the first to embark upon them. Many of the other great nations have already made enormous efforts in the same direction. We have their experience for a guide.

Now, it is not in dispute that wherever agricultural science has been properly organized valuable results have been attained, some of very high importance indeed; yet with full appreciation of these achievements, it is possible to ask whether the whole outcome might not have been greater still. In the course of recent years I have come a good deal into contact with those who in various countries are taking part in such work, and I have been struck with the unanimity that they have shown in their comments on the conditions imposed upon them. Those who receive large numbers of agriculture bulletins purporting to give the results of practical trials and researches will, I feel sure, agree with me that with certain notable exceptions they form on the whole dull reading. True they are in many cases written for farmers and growers in special districts, rather than for the general scientific reader, but I have sometimes asked myself whether those farmers get much more out of this literature than I do. I doubt it greatly. Nevertheless, to the production of these things much labor and expense have been devoted. I am sure, and I believe that most of those engaged in these productions themselves feel, that the effort might have been much better applied elsewhere. Work of this unnecessary kind is done, of course, to satisfy a public opinion which is supposed to demand rapid returns for outlay, and to prefer immediate apparent results, however trivial, to the long delay which is the almost inevitable accompaniment of any serious production. For my own part, I greatly doubt whether in this estimate present public opinion has been rightly gauged. Enlightenment as to the objects, methods and conditions of scientific research is proceeding at a rapid rate. I am quite sure, for example, that no organization of agricultural research now to be inaugurated under the Development Commission will be subjected to the conditions laid down in 1887 when the experimental stations of the United States were established. From them it is decreed in Sec. 4 of the Act of Establishment:

That bulletins or reports of progress shall be published at said stations at least once in three months, one copy of which shall be sent to each newspaper in the states or territories in which they are respectively located, and to such individuals actually engaged in farming as may request the same and as far as the means of the station will permit.

It would be difficult to draft a condition more unfavorable to the primary purpose of the Act, which was "to conduct original researches or verify experiments on the physiology of plants and animals." I can scarcely suppose the most prolific discoverer should be invited to deliver himself more than once a year. Not only does such a rule compel premature publication—that nuisance of modern scientific life—but it puts the investigator into a wrong attitude towards his work. He will do best if he forget the public and the newspaper of his state or territory for long periods, and should only return to them when, after repeated verification, he is quite certain he has something to report.

In this I am sure the best scientific opinion of all countries would be agreed. If it is true that the public really demand continual scraps of results, and can not trust the investigators to pursue research in a reasonable way, then the public should be plainly given to understand that the time for inaugurating researches in the public's name has not arrived. Men of science have in some degree themselves to blame if the outer world has been in any mistake on these points. It can not be too widely known that in all sciences, whether pure or applied, research is nearly always a very slow process, uncertain in production, and full of disappointments. This is true, even in the new industries, chemical and electrical, for instance, where the whole industry has been built up from the beginning on a basis developed entirely by scientific method and by the accumulation of precise knowledge. Much more must any material advance be slow in the case of an ancient art like agriculture, where practise represents the casual experience of untold ages and accurate investigation is of yesterday. Problems moreover relating to unorganized matter are in their nature simpler than those concerned with the properties of living things, a region in which accurate knowledge is more difficult to attain. Here the research of the present day can aspire no higher than to lay the foundation on which the following generations will build. When this is realized it will at once be perceived that both those who are engaged in agricultural research and those who are charged with the supervision and control of these researches must be prepared to exercise a large measure of patience.

The applicable science must be created before it can be applied. It is with the discovery and development of such science that agricultural research will for long enough best occupy its energies. Sometimes, truly, there come moments when a series of obvious improvements in

practise can at once be introduced, but this happens only when the penetrative genius of a Pasteur or a Mendel has worked out the way into a new region of knowledge, and returns with a treasure that all can use. Given the knowledge it will soon enough become applied.

I am not advocating work in the clouds. In all that is attempted we must stick near to the facts. Though the methods of research and of thought must be strict and academic, it is in the farm and the garden that they must be applied. If inspiration is to be found anywhere it will be there. The investigator will do well to work

> As if his highest plot
> To plant the bergamot.

It is only in the closest familiarity with phenomena that we can attain to that perception of their orderly relations, which is the beginning of discovery.

To the creation of applicable science the very highest gifts and training are well devoted. In a foreign country an eminent man of science was speaking to me of a common friend, and he said that as our friend's qualifications were not of the first rank he would have to join the agricultural side of the university. I have heard remarks of similar disparagement at home. Now, whether from the standpoint of agriculture or pure science, I can imagine no policy more stupid and shortsighted.

The man who devotes his life to applied science should be made to feel that he is in the main stream of scientific progress. If he is not, both his work and science at large will suffer. The opportunities of discovery are so few that we can not afford to miss any, and it is to the man of trained mind who is in contact with the phenomena of a great applied science that such opportunities are most often given. Through his hands pass precious material, the outcome sometimes of years of effort and design. To tell him that he must not pursue that inquiry further because he can not foresee a direct and immediate application of the knowledge he would acquire, is, I believe almost always, a course detrimental to the real interests of the applied science. I could name specific instances where in other countries thoroughly competent and zealous investigators have by the shortsightedness of superior officials been thus debarred from following to their conclusion researches of great value and novelty.

In this country where the Development Commission will presumably for many years be the main instigator and controller of agricultural research, the constitution of the advisory board, on which science is largely represented, forms a guarantee that broader counsels will prevail, and it is to be hoped that not merely this inception of the work, but its future administration also will be guided in the same spirit.

So long as a train of inquiry continues to extend, and new knowledge, that most precious commodity, is coming in the enterprise will not be in vain and it will be usually worth while to pursue it.

The relative value of the different parts of knowledge in their application to industry is almost impossible to estimate, and a line of work should not be abandoned until it leads to a dead end, or is lost in a desert of detail.

We have, not only abroad, but also happily in this country, several private firms engaged in various industries—I may mention especially metallurgy, pharmacy and brewing—who have set an admirable example in this matter, instituting researches of a costly and elaborate nature, practically unlimited in scope, connected with the subjects of their several activities, conscious that it is only by men in close touch with the operations of the industry that the discoveries can be made, and well assured that they themselves will not go unrewarded.

Let us on our part beware of giving false hopes. We know no hæmony "of sovran use against all enchantments, mildew blast, or damp." Those who are wise among us do not even seek it yet. Why should we not take the farmer and gardener into our fullest confidence and tell them this? I read lately a newspaper interview with a fruit-farmer who was being questioned as to the success of his undertaking, and spoke of the pests and difficulties with which he had had to contend. He was asked whether the Board of Agriculture and the scientific authorities were not able to help him. He replied that they had done what they could, that they had recommended first one thing and then another, and he had formed the opinion that they were only in an experimental stage. He was perfectly right, and he would hardly have been wrong had he said that in these things science is only approaching the experimental stage. This should be notorious. There is nothing to extenuate. To affect otherwise would be unworthy of the dignity of science.

Those who have the means of informing the public mind on the state of agricultural science should make clear that though something can be done to help the practical man already, the chief realization of the hopes of that science is still very far away, and that it can only be reached by long and strenuous effort, expended in many various directions, most of which must seem to the uninitiated mere profitless wandering. So only will the confidence of the laity be permanently assured towards research.

Nowhere is the need for wide views of our problems more evident than in the study of plant-diseases. Hitherto this side of agriculture and of horticulture, though full of possibilities for the introduction of scientific method, has been examined only in the crudest and most empirical fashion. To name the disease, to burn the affected plants

and to ply the crop with all the sprays and washes in succession ought not to be regarded as the utmost that science can attempt. There is at the present time hardly any comprehensive study of the morbid physiology of plants comparable with that which has been so greatly developed in application to animals. The nature of the resistance to disease characteristic of so many varieties, and the modes by which it may be ensured, offers a most attractive field for research, but it is one in which the advance must be made by the development of pure science, and those who engage in it must be prepared for a long period of labor without ostensible practical results. It has seemed to me that the most likely method of attack is here, as often, an indirect one. We should probably do best if we left the direct and special needs of agriculture for a time out of account, and enlisted the services of pathologists trained in the study of disease as it affects man and animals, a science already developed and far advanced towards success. Such a man, if he were to devote himself to the investigation of the same problems in the case of plants could, I am convinced, make discoveries which would not merely advance the theory of disease-resistance in general very greatly, but would much promote the invention of rational and successful treatment.

As regards the application of genetics to practise, the case is not very different. When I go to the Temple Show or to a great exhibition of live stock, my first feeling is one of admiration and deep humility. Where all is so splendidly done and results so imposing are already attained, is it not mere impertinence to suppose that any advice we are able to give is likely to be of value?

But as soon as one enters into conversation with breeders, one finds that almost all have before them some ideal to which they have not yet attained, operations to perform that they would fain do with greater ease and certainty, and that as a matter of fact, they *are* looking to scientific research as a possible source of the greater knowledge which they require. Can we, without presumption, declare that genetic science is now able to assist these inquirers? In certain selected cases it undoubtedly can—and I will say, moreover, that if the practical men and we students could combine our respective experiences into one head, these cases would already be numerous. On the other hand, it is equally clear that in a great range of examples practise is so far ahead that science can scarcely hope in finite time even to represent what has been done, still less to better the performance. We can not hope to improve the Southdown sheep for its own districts, to take a second off the trotting record, to increase the flavor of the muscat of Alexandria, or to excel the orange and pink of the rose Juliet. Nothing that we know could have made it easier to produce the Rambler roses, or even to evoke the latest novelties in sweet peas, though it may be

claimed that the genetic system of the sweet pea is, as things go, fairly well understood. To do any of these things would require a control of events so lawless and rare that for ages they must probably remain classed as accidents. On the other hand, the modes by which combinations can be made, and by which new forms can be fixed, are through Mendelian analysis and the recent developments of genetic science now reasonably clear, and with that knowledge much of the breeder's work is greatly simplified. This part of the subject is so well understood that I need scarcely do more than allude to it.

A simple and interesting example is furnished by the work which Mr. H. M. Leake is carrying out in the case of cotton in India. The cottons of fine quality grown in India are monopodial in habit, and are consequently late in flowering. In the United Provinces a comparatively early-flowering form is required, as otherwise there is not time for the fruits to ripen. The early varieties are sympodial in habit, and the primary apex does not become a flower. Hitherto no sympodial form with cotton of high quality has existed, but Mr. Leake has now made the combination needed, and has fixed a variety with high-class cotton and the sympodial habit, which is suitable for cultivation in the United Provinces. Until genetic physiology was developed by Mendelian analysis, it is safe to say that a practical achievement of this kind could not have been made with rapidity or certainty. The research was planned on broad lines. In the course of it much light was obtained on the genetics of cotton, and features of interest were discovered which considerably advance our knowledge of heredity in several important respects. This work forms an admirable illustration of that simultaneous progress both towards the solution of a complex physiological problem and also towards the successful attainment of an economic object which should be the constant aim of agricultural research.

Necessarily it follows that such assistance as genetics can at present give is applicable more to the case of plants and animals which can be treated as annuals than to creatures of slower generation. Yet this already is a large area of operations. One of the greatest advances to be claimed for the work is that it should induce raisers of seed crops especially to take more hopeful views of their absolute purification than have hitherto prevailed. It is at present accepted as part of the natural perversity of things that most high-class seed crops must throw "rogues," or that at the best the elimination of these waste plants can only be attained by great labor extended over a vast period of time. Conceivably that view is correct, but no one acquainted with modern genetic science can believe it without most cogent proof. Far more probably we should regard these rogues either as the product of a few definite individuals in the crop, or even as chance impurities brought

in by accidental mixture. In either case they can presumably be got rid of. I may even go further and express a doubt whether that degeneration which is vaguely supposed to be attendant on all seed crops is a physiological reality. Degeneration may perhaps affect plants like the potato which are continually multiplied asexually, though the fact has never been proved satisfactorily. Moreover it is not in question that races of plants taken into unsuitable climates do degenerate rapidly from uncertain causes, but that is quite another matter.

The first question is to determine whether a given rogue has in it any factor which is *dominant* to the corresponding character in the typical plants of the crop. If it has, then we may feel considerable confidence that these rogues have been introduced by accidental mixture. The only alternative, indeed, is cross-fertilization with some distinct variety possessing the dominant, or crossing within the limits of the typical plants themselves occurring in such a way that complementary factors have been brought together. This last is a comparatively infrequent phenomenon, and need not be considered till more probable hypotheses have been disposed of. If the rogues are first crosses the fact can be immediately proved by sowing their seeds, for segregation will then be evident. For example, a truly round seed is occasionally, though very rarely, found on varieties of pea which have wrinkled seeds. I have three times seen such seeds on my own plants. A few more were kindly given me by Mr. Arthur Sutton, and I have also received a few from M. Philippe de Vilmorin—to both of whom I am indebted for most helpful assistance and advice. Of these abnormal or unexpected seeds some died without germinating, but all which did germinate in due course produced the normal mixture of round and wrinkled, proving that a cross had occurred. Cross-fertilization in culinary peas is excessively rare, but it is certainly sometimes effected, doubtless by the leaf-cutter bee (*Megachile*) or a humble-bee visiting flowers in which for some reason the pollen has been inoperative. But in peas crossing is assuredly not the source of the ordinary rogues. These plants have a very peculiar conformation, being tall and straggling, with long internodes, small leaves and small flowers, which together give them a curious wild look. When one compares them with the typical cultivated plants which have a more luxuriant habit, it seems difficult to suppose that the rogue can really be recessive in such a type. True, we can not say definitely *a priori* that any one character is dominant to another, but old preconceptions are so strong that without actual evidence we always incline to think of the wilder and more primitive characteristics as dominants. Nevertheless, from such observations as I have been able to make I can not find any valid reason for doubting that the rogues are really recessives to the type. One feature in particular is quite inconsistent with the belief that these rogues are in any

proper sense degenerative returns to a wild type, for in several examples the rogues have *pointed* pods like the cultivated sorts from which they have presumably been derived. All the more primitive kinds have the dominant stump-ended pod. If the rogues had the stump pods they would fall in the class of dominants, but they have no single quality which can be declared to be certainly dominant to the type, and I see no reason why they may not be actually recessives to it after all. Whether this is the true account or not we shall know for certain next year. Mr. Sutton has given me a quantity of material which we are now investigating at the John Innes Horticultural Institution, and by sowing the seed of a great number of individual plants separately I anticipate that we shall prove the rogue-throwers to be a class apart. The pure types then separately saved should, according to expectation, remain rogue-free, unless further sporting or fresh contamination occurs. If it prove that the long and attenuated rogues are really recessive to the shorter and more robust type, the case will be one of much physiological significance, but I believe a parallel already exists in the case of wheats, for among certain crosses bred by Professor Biffen, some curious spelt-like plants occurred among the derivatives from such robust wheats as Rivet and Red Fife.

There is another large and important class of cases to which similar considerations apply. I refer to the bolting or running to seed of crops grown as biennials, especially root crops. It has hitherto been universally supposed that the loss due to this cause, amounting in sugar beet as it frequently does to five, or even more, per cent., is not preventable. This may prove to be the truth, but I think it is not impossible that the bolters can be wholly, or almost wholly, eliminated by the application of proper breeding methods. In this particular example I know that season and conditions of cultivation count for a good deal in promoting or checking the tendency to run to seed, nevertheless one can scarcely witness the sharp distinction between the annual and biennial forms without suspecting that genetic composition is largely responsible. If it proves to be so, we shall have another remarkable illustration of the direct applicability of knowledge gained from a purely academic source. "Let not him that putteth his armor on boast him as he that putteth it off," and I am quite alive to the many obstacles which may lie between the conception of an idea and its realization. One thing, however, is certain, that we have now the power to formulate rightly the question which the breeder is to put to nature; and this power and the whole apparatus by which he can obtain an answer to his question—in whatever sense that answer may be given—has been derived from experiments designed with the immediate object of investigating that scholastic and seemingly barren problem, "What is a species?" If Mendel's eight years' work had been done in an

agricultural school supported by public money, I can imagine much shaking of heads on the county council governing that institution, and yet it is no longer in dispute that he provided the one bit of solid discovery upon which all breeding practise will henceforth be based.

Everywhere the same need for accurate knowledge is apparent. I suppose horse-breeding is an art which has by the application of common sense and great experience been carried to about as high a point of perfection as any. Yet even here I have seen a mistake made which is obvious to any one accustomed to analytical breeding. Among a number of stallions provided at great expense to improve the breed of horses in a certain district was one which was shown me as something of a curiosity. This particular animal had been bred by one of the provided stallions out of an indifferent country mare. It had been kept as an unusually good-looking colt, and was now traveling the country as a breeding stallion, under the highest auspices. I thought to myself that if such a practise is sanctioned by breeding acumen and common sense, science is not after all so very ambitious if she aspires to do rather better. The breeder has continually to remind himself that it is not what the animal or plant *looks* that matters, but what it *is*. Analysis has taught us to realize, first, that each animal and plant is a double structure, and next that the appearance may show only half its composition.

With respect to the inheritance of many physiological qualities of divers kinds we have made at least a beginning of knowledge, but there is one class of phenomena as yet almost untouched. This is the miscellaneous group of attributes which are usually measured in terms of size, fertility, yield and the like. This group of characters has more than common significance to the practical man. Analysis of them can nevertheless only become possible when pure science has progressed far beyond the point yet reached.

I know few lines of pure research more attractive and at the same time more likely to lead to economic results than an investigation of the nature of variation in size of the whole organism or of its parts. By what factors is it caused? By what steps does it proceed? By what limitations is it beset? In illustration of the application of these questions I may refer to a variety of topics that have been lately brought to my notice. In the case of merino sheep I have been asked by an Australian breeder whether it is possible to combine the optimum length of wool with the optimum fineness and the right degree of crimping. I have to reply that absolutely nothing is yet known for certain as to the physiological factors determining the length or the fineness of wool. The crimping of the fibers is an expression of the fact that each particular hair is curved, and if free and untwisted would form a corkscrew spiral, but as to the genetics of curly hair even in man very little

is yet known. But leaving the question of curl on one side, we have in regard to the length and fineness of wool, a problem which genetic experiment ought to be able to solve. Note that in it, as in almost all problems of the "yield" of any product of farm or garden, two distinct elements are concerned—the one is *size,* and the other is *number.* The length of the hair is determined by the rate of excretion and length of the period of activity of the hair follicles, but the fineness is determined by the number of follicles in unit area. Now analogy is never a safe guide, but I think if we had before us the results of really critical experiments on the genetics of size and number of multiple organs in any animal or even any plant, we might not wholly be at a loss in dealing with this important problem.

A somewhat similar question comes from South Africa. Is it possible to combine the qualities of a strain of ostriches which has extra long plumes with those of another strain which has its plumes extra lustrous? I have not been able fully to satisfy myself upon what the luster depends, but I incline to think it is an expression of fineness of fiber, which again is probably a consequence of the smallness and increased number of the excreting cells, somewhat as the fineness of wool is a consequence of the increased number and smallness of the excreting follicles.

Again the question arises in regard to flax, how should a strain be bred which shall combine the maximum length with maximum fineness of fiber? The element of number comes in here, not merely with regard to the number of fibers in a stem, but also in two other considerations, first, that the plant should not tiller at the base, and, secondly, that the decussation of the flowering branches should be postponed to the highest possible level.

Now in this problem of the flax, and not impossibly in the others I have named, we have questions which can in all likelihood be solved in a form which will be of general, if not of universal, application to a host of other cognate questions. By good luck the required type of flax may be struck at once, in which case it may be fixed by ordinary Mendelian analysis, but if the problem is investigated by accurate methods on a large scale, the results may show the way into some of those general problems of size and number which make a great part of the fundamental mystery of growth.

I see no reason why these things should remain inscrutable. There is indeed a little light already. We are well acquainted with a few examples in which the genetic behavior of these properties is fairly definite. We have examples in which, when two varieties differing in number of divisions are crossed, the lower number dominates—or, in other words, that the increased number is a consequence of the removal of a factor which prevents or inhibits particular divisions, so that they

do not take place. It is likely that in so far as the increased productivity of a domesticated form as compared with its wild original depends on more frequent division, the increase is due to loss of inhibiting factors. How far may this reasoning be extended? Again we know that in several plants—peas, sweet peas, *Antirrhinum* and certain wheats—a tall variety differs in that respect from a dwarf in possessing one more factor. It would be an extraordinarily valuable addition to knowledge if we could ascertain exactly how this factor operates, how much of its action is due to linear repetition, and how much to actual extension of individual parts. The analysis of the plants of intermediate size has never been properly attempted, but would be full of interest and have innumerable bearings on other cases in animals and plants, some of much economic importance.

That in all such examples the objective phenomena we see are primarily the consequence of the interaction of genetic factors is almost certain. The lay mind is at first disposed, as always, to attribute such distinctions to anything rather than to a specific cause which is invisible. An appeal to differences in conditions—which a moment's reflection shows to be either imaginary or altogether independent—or to those vague influences invoked under the name of selection, silently postponing any laborious analysis of the nature of the material selected, repels curiosity for a time, and is lifted as a veil before the actual phenomena; and so even critical intelligences may for an indefinite time be satisfied that there is no specific problem to be investigated, in the same facile way that, till a few years ago, we were all content with the belief that malarial fevers could be referred to any damp exhalations in the atmosphere, or that in suppuration the body was discharging its natural humors. In the economics of breeding, a thousand such phenomena are similarly waiting for analysis and reference to their specific causes. What, for instance, is self-sterility? The phenomenon is very widely spread among plants, and is far commoner than most people suppose who have not specially looked for it. Why is it that the pollen of an individual in these plants fails to fertilize the ova of the same individual? Asexual multiplication seems in no way to affect the case. The American experimenters are doubtless right in attributing the failure of large plantations of a single variety of apples or of pears in a high degree to this cause. Sometimes, as Mr. W. O. Backhouse has found in his work on plums at the John Innes Horticultural Institution, the behavior of the varieties is most definite and specific. He carefully self-fertilized a number of varieties, excluding casual pollination, and found that while some sorts, for example, Victoria, Czar and Early Transparent set practically every fruit self-pollinated, others including several (perhaps all) Greengages, Early Orleans and Sultan do not set a single fruit without pollination from some other variety.

Dr. Erwin Baur has found indications that self-sterility in *Antirrhinum* may be a Mendelian recessive, but whether this important suggestion be confirmed or not, the subject is worth the most minute study in all its bearings. The treatment of this problem well illustrates the proper scope of an applied science. The economic value of an exact determination of the empirical facts is obvious, but it should be the ambition of any one engaging in such a research to penetrate further. If we can grasp the *rationale* of self-sterility we open a new chapter in the study of life. It may contain the solution of the question, What is an individual?—no mere metaphysical conundrum, but a physiological problem of fundamental significance.

What, again, is the meaning of that wonderful increase in size or in "yield" which so often follows on a first cross? We are no longer content, as Victorian teleology was, to call it a "beneficial" effect and pass on. The fact has long been known and made use of in breeding stock for the meat market, and of late years the practise has also been introduced in raising table poultry. Mr. G. N. Collins,[2] of the U. S. Department of Agriculture, has recently proposed with much reason that it might be applied in the case of maize. The cross is easy to make on a commercial scale, and the gain in yield is striking, the increase ranging as high as 95 per cent. These figures sound extravagant, but from what I have frequently seen in peas and sweet peas, I am prepared for even greater increase. But what *is* this increase? How much of it is due to change in number of parts, how much to transference of differentiation or homœosis, as I have called it—leaf-buds becoming flower-buds, for instance—and how much to actual increase in size of parts? To answer these questions would be to make an addition to human knowledge of incalculably great significance.

Then we have the further question, How and why does the increase disappear in subsequent generations? The very uniformity of the cross-breds between pure strains must be taken as an indication that the phenomenon is orderly. Its subsidence is probably orderly also. Shull has advocated the most natural view that heterozygosis is the exciting cause, and that with the gradual return to the homozygous state the effects pass off. I quite think this may be a part of the explanation, but I feel difficulties, which need not here be detailed, in accepting this as a complete account. Some of the effect we may probably also attribute to the combination of complementary factors; but whether heterozygosis, or complementary action, is at work, our experience of cross-breeding in general makes it practically certain that genetic factors of special classes only can have these properties, and no pains should be spared in identifying them. It is not impossible that such identifi-

[2] Bureau of Plant Industry, Bulletin No. 191, 1910.

cation would throw light on the nature of cell division and of that meristic process by which the repeated organs of living things are constituted, and I have much confidence that in the course of the analysis discoveries will be made bearing directly both on the general theory of heredity and on the practical industry of breeding.

In the application of science to the arts of agriculture, chemistry, the foundation of sciences, very properly and inevitably came first, while breeding remained under the unchallenged control of simple common sense alone. The science of genetics is so young that when we speak of what it also can do we must still for the most part ask for a long credit; but I think that if there is full cooperation between the practical breeder and the scientific experimenter, we shall be able to redeem our bonds at no remotely distant date. In the mysterious properties of the living bodies of plants and animals there is an engine capable of wonders scarcely yet suspected, waiting only for the constructive government of the human mind. Even in the seemingly rigorous tests and trials which have been applied to living material apparently homogeneous, it is not doubtful that error has often come in by reason of the individual genetic heterogeneity of the plants and animals chosen. A batch of fruit trees may be all of the same variety, but the stocks on which the variety was grafted have hitherto been almost always seminally distinct individuals, each with its own powers of luxuriance or restriction, their own root-systems and properties so diverse that only in experiments on a colossal scale can this diversity be supposed to be levelled down. Even in a closely bred strain of cattle, though all may agree in their "points," there may still be great genetic diversity in powers of assimilation and rapidity of attaining maturity, by which irregularities by no means negligible are introduced. The range of powers which organic variation and genetic composition can confer is so vast as to override great dissimilarities in the conditions of cultivation. This truth is familiar to every raiser and grower who knows it in the form that the first necessity is for him to get the right breed and the right variety for his work. If he has a wheat of poor yield, no amount of attention to cultivation or manuring will give a good crop. An animal that is a bad doer will remain so in the finest pasture. All praise and gratitude to the student of the conditions of life, for he can do, and has done, much for agriculture, but the breeder can do even more.

When more than fifteen years ago the proposal to found a school of agriculture in Cambridge was being debated, much was said of the importance of the chemistry of soils, of researches into the physiological value of food-stuffs, and of other matters then already prominent on the scientific horizon. I remember then interpolating with an appeal for some study of the physiology of breeding, which I urged should

find a place in the curriculum, and I pointed out that the improvement in the strains of plants and animals had done at least as much —more, I really meant—to advance agriculture than had been accomplished by other means. My advice found little favor, and I was taken to task, afterwards, by a prominent advocate of the new school for raising a side issue. Breeding was a purely empirical affair. Common sense and selection comprised the whole business, and physiology flew at higher game. I am, nevertheless, happy now to reflect that of the work which is making the Cambridge School of Agriculture a force for progress in the agricultural world the remarkable researches and results of my late colleague, Professor Biffen, based as they have been on modern discoveries in the pure sciences of breeding, occupy a high and greatly honored place.

In conclusion I would sound once more the note with which I began. If we are to progress fast there must be no separation made between pure and applied science. The practical man with his wide knowledge of specific natural facts, and the scientific student ever seeking to find the hard general truths which the diversity of nature hides —truths out of which any lasting structure of progress must be built —have everything to gain from free interchange of experience and ideas. To ensure this community of purpose those who are engaged in scientific work should continually strive to make their aims and methods known at large, neither exaggerating their confidence nor concealing their misgivings,

> Till the world is wrought
> To sympathy with hopes and fears it heeded not.

CIVILIZATION AND VEGETATION

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CERTAIN experiences, national and personal, have caused me to reflect of late on this subject, the outlines and meaning of which will become clear, I hope, as we proceed.

With the modesty which we all recognize to be the supreme characteristic distinguishing man from all other living organisms, we regard the human race as the dominant one in nature. We consider it not only the one whose mental, if not physical, evolution has proceeded furthest toward the highest good, but the one which by natural or divine right should subjugate and rule all others, should domesticate or exterminate at will, should plow or disembowel the earth, should make the desert bear crops or strip the slopes of their forest cover, centuries old. In fact, so complete is human modesty, that the race does all these things and many more with no thought but as to the means and the gain, never a question as to the right. That is modestly assumed.

Human modesty even goes so far as to compel competition among men. The gross material cannibalism that once prevailed has given place to that refined cannibalism which, on bourse and stock exchange, in manufacture and sale of commodities, even in the numberless Olympuses of our American colleges, "eats up" the "lambs," devours the weak competitor, and oppresses the friendless. Peace is not in the scheme of nature, that nature in which man has taken the rôle of Ishmael, whose hand was against every man and every man's hand against him.

With this Ishmael, as in all nature, struggle is universal and inevitable; struggle, competition, war if you will, which can have only one end, the extermination of one of the strugglers. There is such a thing as extermination by assimilation. The King of the Cannibal Islands exterminated the first missionaries by assimilating them after murder. We are to-day exterminating the Indian as such by assimilating him without murder as certainly as in the days of the Indian wars.

Where are the races of wild animals from which we have "developed" cows and hens, the intelligence, alertness and gaiety of whose countenances is so obvious? We have assimilated them. Some of their excellences have even been imitated on the stage.

What is the joy of living as a tame hen, as a domesticated cow, as a pruned pear tree? "The ox that treadeth out corn" is sure of daily food; so is "the cock of the walk"; so also are the subjugated plants of

farm and garden; but individuality has been sacrificed for safety, they have been conquered in the war which every man is waging against every other living thing, human or other.

Whether the Ishmaelitic rôle of man in nature be right or wrong, it is very real, and we can not escape playing our share in that rôle. It may be merely as competitors against other human beings, holding the positions which others would like, but which we call ours; or it may be as competitors against other kinds of organisms.

On beautiful spring days, when the country calls us from desk and laboratory, we see the fields turning over under the plow, the wild flowers, the native shrubs, and the young trees existing, if at all, only in the fence corners, the trees and other plants of the wood-lot leaping their bounds only to be killed bye and bye by the cultivator. In place of the variety which once covered an acre, we shall presently see only a waving field of grain, wheat or barley or oats, no one of which is native; or there will come up corn in formal rows which can reach its hypertrophic maturity only by the destruction of numberless smaller plants of which this field was once the possession. Or the unnatural trees of an orchard shade a hillside on which once stood a forest, and in place of clear streams the air tinkles with the music of brooks and creeks turbid with soil and perhaps infected with typhoid.

This last is an evidence of revenge. Civilization and man do not have things without struggle, although the outcome of the struggle is certain. Civilization and man will triumph, but not without great mortality on both sides. In the natural forest and on the natural prairie, untouched by man's invasion or by fire or by other profound disturbance, the balance is fairly maintained year after year. Last summer in the northern Rockies, I was struck by the fact that the forest does not encroach on the grass land, nor this spread into the timber. Generation after generation, they are the same, with great grassy bays here and there into the forest and high capes and promontories of timber stretching out into the grazing land. The trees and the grasses bear and shed seed year by year; insects eat the foliage or tunnel bark and wood; parasitic fungi cause smut or rust or rot; but neither set of enemies produces an epidemic or decimates the plant population, nor does the population greatly change. But let man clear the land of its stable native population, and the difference is at once apparent. If he attempt to raise a crop, he must fight as a weed every native plant, or cut back the timber to secure sunshine; he must drain his fields of excessive moisture, but in such manner as to conserve enough; he must till so that fresh soil may be brought to the roots of successive crops; and he must soon begin the endless use of insecticides, fungicides and fertilizers because of the apparently sudden increase in enemies and decrease in fertility. This is what he pays for trying to substitute his balance of

population for that of nature. By tools and sprays he drives back the larger and more minute representatives of the former population until finally they are to be found only in such places as man may not yet wish to use for the other purposes. In Muir's "Mountains of California," in the chapter entitled The Bee-Pastures, he describes what used to be. "The Great Central Plain of California during the months of March, April and May, was one smooth continuous bed of honey-bloom, so marvellously rich that in walking from one end of it to the other, a distance of 400 miles, your foot would press about a hundred flowers at every step. The radiant honey-filled corollas, touching and over lapping, and rising above one another, glowed in the living light like a sunset sky—one sheet of purple and gold, with the bright Sacramento pouring through the midst of it from the north, the San Joaquin from the south, and their many tributaries sweeping in at right angles from the mountains, dividing the plain into sections fringed with trees." Now that plain is a checkerboard of grain and alfalfa fields bounded by irrigation ditches. And the lesser valleys, parallel with this great central plain, bounded by mountains still more or less timbered, are consecrated to the culture—of prunes. Undisturbed nature is still accessible, nearer at hand in that golden west than in the green middle west or on the Atlantic slope. Even the tourist can reach it if he will; not in Yosemite with its hotel, camps, and mule-polluted trails; but beyond, at the top of the world, in the higher places of the Sierra.

Civilization in the form of agriculture plays sad havoc with natural native vegetation, destroying, driving back, exterminating most, domesticating and assimilating few, plants.

Where agriculture has not yet reached, the lumberman hews down that man may elsewhere build up. There is, so far as I know, only one of our forests which, given a fair chance, will quickly reproduce itself. The redwood forest which used to stretch for hundreds of miles unbroken over the eastward as well as the westward slopes of the mountains closely paralleling the coast line of California, can reproduce itself and does wherever the lumberman fails to clear by the cheap and costly means of fire. The redwood suckers like a lilac, a rare quality in conifers. If the underground parts of a felled tree are left alive, suckers will spring up, and by their astonishingly rapid growth, almost throughout the twelve month, drenched in life-giving fogs in the rainless summer and checked only by the coldest weather of the mild and rainy winter, they will yield a stand which in thirty years will be merchantable timber. Meantime the soil is held in place, the wash is slow and comparatively harmless, the streams are clear, and those turbid destructive floods so common elsewhere, are almost unknown.

The vast areas which the nation has saved from the lumberman to furnish timber for our children and their children, to cover the water-

sheds and to conserve and control the yearly run-off, are annually placed in jeopardy by the railroads. Last year, disastrous fires in the far northwest, and the less extensive fires of Wisconsin and Minnesota in the summer preceding, only too plainly showed this. So dreadful has been the loss of human life and of property from this cause that the substitution of sparkless fuel-oil on locomotives traversing forested areas is now not only urged by the forest service, but being seriously considered by the railway companies. Until electric traction or sparkless fuel is employed, each dry season will bring its record of destruction along the tracks of civilization through forest and grazing land.

Reaching almost as far from its source as the fires accidentally set by civilization, is the destruction of vegetation by certain forms of industry. The damage is done in two ways, by drainage and by fumes. The composition of ordinary domestic drainage is disturbing enough to vegetation. I have had occasion to notice this along the shore of Monterey Bay. When I first saw these waters they were bordered on one side by the towns of Monterey and Pacific Grove, sleeping peacefully, the one after a somewhat turbulent past, the other on federal and denominational pensions. Between tide marks and further out were a fauna and flora so rich and so varied that a few years earlier, when the whole coast of California was open for such a choice, this had been selected as the best location for the Marine Biological Laboratory of Stanford University. So far as I can see, the fauna and flora are as rich to-day as then, but with the recent rapid increase in population of these two towns and the consequent increase in sewage pouring into the bay at no great distance below low-tide mark, there has been a decided increase in the quantity of diatoms living attached to the seaweeds growing between tide marks. The body of water in Monterey Bay is so very large and so thoroughly mixed by the tides, and the volume of sewage discharged into it from the towns on its shores is still so small in comparison, that the sea-water, even now, deserves to be called pure. But it is no longer perfect purity. Its increasing though still relatively slight pollution is shown by the change in the balance of the population between tide marks, by indicators exceeding in sensitiveness those of the chemical laboratory, by living things. We all know that, when pollution goes further, certain plants are no longer found in stream and bay; river and mud-flat become huge cultures in which coarse algæ and offensive bacteria flourish.

In all such changes as these, however, there is only a change, not a decrease in the value of the water as a nutrient solution. Nothing poisonous has been added to it, only substances which so abundantly nourish bacteria, blue-green algæ, diatoms and coarse green algæ, that other forms become more or less crowded out. This is so common an effect of civilization on vegetation that we think nothing of it. On the

other hand, the actual poisoning of plants and animals by drainage from industrial establishments attracts much more attention and in many states is forbidden by law. When there are no longer trout in a once famous fishing stream people are much more likely to notice and to remedy the injury than if sawdust or tailings merely make the stream and its borders unsightly or desolate. In the parts of the west dependent upon irrigation, drainage from mines or works which makes the water poisonous to the crops, arouses the public much more than the pollution which makes it dangerous to drink.

Perhaps it is but natural, and only another exhibition of that modesty which constitutes the distinguishing characteristic of the human species, at all events those influences which affect man and other animals are more likely to be recognized by him than those which affect plants; and those which affect his quick-growing crops, with their more frequent money returns, are more promptly recognized than those which may greatly augment or diminish a harvest coming only twice or thrice in a century. What do we know of the effects of illuminating gas in our houses and gardens, of the effects of the gaseous emanations from domestic and factory fires upon the trees of streets and parks? The only reason why gas-piping is no worse, is that greater leakage would be unprofitable to the gas companies, even at the present high rates. As it is, our houses and laboratories reek of gas to the sensitive nostril, and garden and green-house yield less than they would if the soil were not traversed by badly jointed pipes.

We think and speak of the smoke nuisance as if it were merely a soot nuisance. We do not realize that the most perfect and ideal "smoke consumer," which would certainly lessen our laundry bills, would utterly fail to lengthen life. The most perfect fuels, because the least injurious, are wood and alcohol. How often have we seen a farm-house overtopped by some great tree and through its branches the fragrant wood-smoke floating gently from the chimney. The substitution of coal for wood would be quickly followed by a succession of troubles which would finally kill the tree, not by "closing its pores" with soot, but by poisoning the living cells in leaves and branches by the sulphur and chlorine fumes given off in burning the coal. So in our towns, you may see holes in what should be domes of foliage, bits of sky through what should be hollow masses of translucent green, olives and yellows when there should be a brilliant verdure. More careful examination will show that not only is the foliage deficient in amount and defective in color in carefully tended city trees, but their annual growth in length and thickness is less than that of their fellows uncared for in the purer air beyond the outmost suburbs. The much advertised "tree surgery" of to-day is a species of not altogether useless quackery, developed to treat a symptom in communities which do not yet recog-

nize and remove the cause of disease. Between gas in the soil and gases in the air urban trees lead a more or less poisoned and morbid existence, appreciated and enjoyed only by those who can not or will not go where trees grow rapidly and well, solitary or gregarious, according to their kinds, a delight to the eye, an inspiration to the spirit, a shelter to the birds, and a satisfaction to the lumberman.

Perhaps this seems an exaggerated statement of urban conditions, but an examination of the trees in the parks of Pittsburgh, Cincinnati, St. Louis and Chicago, among the industrial cities using mainly soft coal, and of New York and Boston, in which hard coal is the principal fuel, will convince the fair-minded observer that something is wrong.

Air and soil analyses and experiments under controllable conditions, will alone reveal the cause of the condition of urban trees and of those growing near industrial plants from which poisonous fumes emanate. Such analyses of air and soil can be made only by a skilled chemist, and such experiments should be attempted only when a skilled chemist and a trained biologist can cooperate under such conditions of climate and equipment as to justify the expenditure of time and money.

In the remarkably pure air of Stanford University, with the nearest domestic coal fire a quarter mile away and with gas supplied to the university by a single small main, a greenhouse has been so constructed that it is completely divided into two exactly similar halves, in which experiments and their controls can be carried on under as nearly natural conditions as can be conceived. In each half of this house there were boxes of growing grain, a considerable variety of potted seedling trees, one, two and three years old, and other plants, aquatic and terrestrial. The grain was grown on the spot from seeds; the trees were grown from the seed in the pots and were brought into the house so long before they were used in experiments, that they were quite accustomed to their surroundings. Into one half of the experiment house, a dose of sulphur dioxide equal to the proportion in pure city air, was introduced daily (Sundays excepted) for months, during the resting period only for one set of trees, during the growing period only of another set, and during the resting and most of the growing period of a third set.

The trees continuously in the side of the house dosed daily with a very minute quantity of sulphur dioxide gas, blown into and thoroughly mixed with the air of the house, showed a growth in length two thirds of that of the trees in the pure air of the other half of the house. There are no visible injuries; only measurement shows that those trees in air purer than that of most cities do not thrive, do not make as much growth as trees in thoroughly pure air. Analyses show that the sulphur dioxide is fixed, mainly in the leaves, and thus disturbs the vital activities of plants. The results with grain correspond. These results obtained by experiment justify, therefore, the assertion that the problem

of urban smoke is one of gases as well as solids, of poisonous fumes as well as inconvenient soot.

Turning now from cities, in which the growth of plants is purely for pleasure, and by no means natural or commercially profitable, we may ask what are the effects of smelting and other works from which poisonous fumes may be discharged?

Manufactories of certain chemicals, or of materials in the preparation of which poisonous substances may be volatilized, and establishments in which sulphurous ores are roasted either for the extraction of the metal or in order to obtain sulphur for the preparation of sulphuric acid, will affect surrounding vegetation more or less seriously. Even locomotive smoke injures the plants along the railroads, as anyone may observe. The herbaceous plants along the track, but quite beyond the reach of steam, often show burned spots on their leaves and stems. These are acid burns due to the fumes, of sulphur principally, discharged from the smoke-stacks of passing engines. One seldom travels over an old railway through woods or forests in which there are not many trees close to the line with branches or tops dead. Often the immediate cause of death is insects or fungi or possibly bacteria; just as tuberculosis may be the immediate cause of death in factory workers debilitated by long hours of labor under conditions unfavorable to robust health. But in many cases, locomotive smoke can be shown to be the immediate as well as the mediate cause of damage or death to trees along a railroad.

Such cases as these are, however, as unimportant, except as showing a principle, as they are at present unavoidable. On the other hand, where the prosecution of one industry results in the injury of many others, in the destruction of property, public as well as private, and in such changes in the run-off that the flow of water in streams perhaps hundreds of miles away is affected, the question becomes one of great importance. An illustration of this is found in the southeast corner of Tennessee, where, for many years, a low-grade copper ore, rich in sulphur, has been smelted. There are now two smelters in that region. The country is mountainous, the slopes naturally covered with the large-leaved mixed forest of the southern Appalachians, well watered by the frequent summer rains. The virgin forest was long ago cut for mine-timbers and for fuel in that extensive district known as Ducktown, but the second growth is also gone and, up to three years ago, nothing of any value could be cultivated within a distance of miles from these smelters. In the suit won by the state of Georgia before the Supreme Court of the United States, it was shown that the poisonous effects of the fumes were visible in Georgia at a distance of forty miles from these Tennessee smelters. Three and a half years ago, so hopeless was the condition of the people attempting to farm there, that they declared

even the soil was poisoned, a mistake, of course. Since there is scarcely any level land in that district, one may imagine the result of removing the forest cover, destroying the undergrowth and preventing any other vegetation which might cover the naked soil with its branches or leaves and hold it together and in place with its roots. Instead, the leaf-mold accumulated during centuries on the forest floor and the fine soil worked and re-worked by roots, worms and other occupants of the ground, were quickly washed down the slopes into the turbid streams, floods took the place of the spring freshets, and the bare earth battered by the rains constantly gave its fertility to the already rich lowlands far away, or to the still more distant and unneeding sea.

Conditions are better now. Instead of throwing away as a poisonous waste the sulphur dioxide formed in smelting their ores, the smelters are now collecting as large a proportion of this gas as possible for the manufacture of sulphuric acid. This they sell to the manufacturers of phosphate fertilizer. Instruction is leading to improved methods of farming, to the use of the phosphates made from converted smelter waste, the farms are beginning to yield crops which repay tillage, and the woodlands are improving. To complete this romance of industry reformed under federal compulsion, it need only be said that the manufacture of sulphuric acid is so profitable that the smelters would be run for that purpose now if for no other, and that their copper costs them nothing!

In this conflict of industry with agriculture and the native vegetation the outcome has been a happy one; for industry, forced to recognize prior and more general rights, has been so modified as to eliminate its injurious effects and to enhance its own profits. This is seldom possible to anything like the same extent. The greater the industrial plant requiring reform, the more intense and extensive the damage it does, and the greater must be the difficulty of making the needed changes in method of operation. And yet even manufacturers are coming to see, by compulsion to be sure in most cases, that their rights are not unlimited, that they must conduct their business in such a manner that agricultural or other legitimate and established interests will not suffer and that the property of the nation be not injured.

This is the significance of the agreement reported in the newspapers as recently made by the Attorney General of the United States with the owners of the great smelters in Montana. These smeltermen, rather than fight a suit brought in the federal court by the Attorney General, have promised to modify their methods of extracting copper and the other metals from their ores, so that they will no longer injure the property of the nation. One of these smelters handles 10,000 tons of ore per day, when running to its capacity, and last summer I drove twenty-five miles away from it, passing over the continental divide,

before reaching apparently sound uninjured forest. Such has been the widespread damage by one industrial plant in the ten years of its existence. The national forests at the headwaters of the Missouri and the Columbia are dying, and the Attorney General, in compelling their protection by reform in the extraction of copper, has done his duty well.

Another case in point is afforded by a recent decision in southern California. In the heart of the orange-producing region of the San Bernardino valley, the manufacture of cement, begun on a small scale, has developed to considerable proportions. Going eastward on the Southern Pacific Railroad from Los Angeles, one passes through almost continuous groves of orange trees, their dark green leaves glistening in the brilliant sunshine which has given that land its name. Suddenly one notices that the foliage is no longer green, but gray, not glossy but dull, and that on the opposite side of the train is a cement works constantly wasting part of its laboriously manufactured product. This dust settles on leaves and soil, enters houses, and becomes a nuisance everywhere. It sets wherever there is moisture, in dew or fog or rain, and does not wash off like ordinary dust. By reason of this opaque coating over the leaves, the manufacture of food in these green organs is interfered with, and the insufficiently nourished trees yield a correspondingly diminished crop. So serious has this injury to the orange industry become, that the court has decided that the manufacture of cement in one plant must be stopped entirely, and in another may be carried on only on a small scale, until such changes have been made that manufacture can be resumed without disadvantage to the orange-growers. That such changes will be made in this plant I have no doubt.

Such cases as this, revealing the conflict of civilization and vegetation, decided with wisdom as well as justice, leading to improved methods of manufacture, go far toward establishing that new balance which must be attained in America, as it was reached long ago in more populous Europe, that balance between civilization and vegetation which will ensure the stability and the prosperity of both.

ENGLISH AS AN INTERNATIONAL LANGUAGE

By Professor ALBERT LEON GUÉRARD

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OF our thousand languages, great and small, dead and living, natural and artificial, from Edenese to Esperanto, which is to be the world-speech of the future? "Why, English, of course!" America replies with one mighty voice, in which rings the indomitable optimism of the nation. Now, I love English dearly, for having spent twelve years of my youth in trying to master some of its intricacies; I love America still more, for her generous hospitality, which I am at present enjoying, and yet I find myself unable to join in the chorus so ably led by Professor Brander Matthews. I do not believe that English is destined to be the international language of to-morrow. On this side of the Atlantic, this may sound paradoxical; across the water, it is accepted as a truism, even in England. Let us suppose ourselves in a neutral zone, and examine judicially the pros and cons of the case.

Faith in the future supremacy of English can certainly not be lightly dismissed as a mere chauvinistic delusion. It is based on personal experience: we all know how eagerly the better class of immigrants take up the study of the language; how impatient their children are of any other tongue; we know that, with nothing but English and money at our command, we can be understood, and respectfully fleeced, in all the best hotels in the world. Statistics give scientific support to these individual impressions. One half of the world's commerce, two thirds of its shippping, one fourth of its population, one half of its railroads, of its newspapers, of its postal transactions, are under the control of the English-speaking countries. Grammatical and literary arguments can then be brought forward in favor of English: its grammar actually simpler in some respects than that of Esperanto, its international quality as a strongly Romanized Teutonic language, its wonderful vocabulary which can be extended in all directions without losing its unity, the unrivaled freedom of its syntax, which enables it to use the same word as a noun, a verb, an adjective or a preposition; last but not least, its unbroken literary record, and myriad-souled Shakespeare as supreme argument.

All this has to be granted, and is granted without reluctance. No one denies that English is one of the three or four world-languages, and a prince among its peers. But that it will ever attain the unique position once held by Greek, Latin or French does not by any means follow.

There are three ways for a language to achieve universality: political

domination, natural development, international agreement. It was through the political domination of Rome that Latin spread over the whole of the ancient world. It is through the same agency that English was and is diffused in Ireland, India and the Philippines; French in Languedoc, Provence, Brittany, Flanders and the colonies; German in Slesvig, Poland and Lorraine. Should England and America conquer the world, or simply control the world, English would become everywhere what it is in India: the language of government, modern culture and commerce.

It can not be denied that the British Empire alone is larger, richer, more varied, more powerful, than Rome ever was under Augustus or Trajan. But Rome stood as practically the sole representative of civilization: side by side with the Anglo-Saxon world there are other worlds —Germanic, Slavonic, Latin and Mongolian, hardly inferior in material development, and in some respects fully equal in culture. That the fate of Carthage and Greece awaits France and Germany can not be suggested, except in jest. Ten or twelve years ago, conditions were different. Anglo-Saxondom was a religion—hardly less aggressive than Islam under Mohammed; Rhodes and Rudyard Kipling were its prophets. China, South America, the colonies of Portugal, Holland and France were to be turned into Anglo-Saxon dependencies. Sometimes Germany was bidden to the feast, as a poor relation, and the London *Daily Mail* published highly sensational maps of the coming partitions. Where are the dreams of yestereve? The threatened nations have prospered unimpeded; other claimants to world-wide influence have come and gone for a season, like Russia—or come to stay, like Japan. The acknowledged weakness of Anglo-Saxondom in land forces has had a wonderful sobering effect, and, more than anything else, the growing sense of international justice, the thorough sanity of Great Britain and the United States, have contributed to dispel those unholy fancies.

Besides, linguistic domination does not always follow political domination, unless there be an overwhelming disparity of forces, material and moral, between the ruling people and their subjects. The Tagals will learn English and the Malagasy French, but it is more than doubtful that Mexico, conquered by the States, would learn the language of their victors. The willingness with which immigrants adopt English must not mislead us. Numerous as they are, they are, at any given moment, a minority. They come unorganized, severed from their traditions, into a highly civilized country with a strong national feeling. Yet, the point of saturation might soon be reached. Wherever in the British Empire the non-English elements are compact and have a tradition back of them, they maintain their language with curious pertinacity, like the Boers and the Habitants. Even the French in Louisiana, although they were but a handful, have not yet been fully

assimilated. Greek profited at least as much as Latin by the Roman conquest of the world. After a century of union with the Empire of the Tsars, the best educated inhabitants of Finland learn German rather than Russian. Magyar, Czech and Polish have triumphantly asserted themselves against German, once the only official language in the Hapsburg dominions. After forty years of strenuous endeavor, the German Empire has not shaken the hold of French culture in the essentially Teutonic province of Alsace. When one hears of the incessant struggle in Germany, Austria-Hungary and Russia, caused by the attempt of imposing a language on a conquered people, one can not but hope that England and America will be wise and generous enough not to commit the same mistake—or the same crime.

Without any coercion, the natural superiority of a language, or of the civilization which it represents, will ensure its triumph. Thus Cornish disappeared and Welsh is receding before English; thus, for a time, and without any political connection between the two countries, Rumanian was entirely overshadowed by French. By a process of natural selection, some languages remain provincial, like Basque or Breton; some become national, like Hungarian; and a few conquer international status. Among these, by a similar process, one will forge ahead of all others and become alone international: such is the destiny claimed for English.

All this is theory: do facts point the same way? It seems that every year we have more claimants instead of fewer to national and international rank. A century ago, French was alone in the field. At present, not only French, German and English, but Italian enjoys in all international activities a sort of official recognition. And how long will Spanish and Russian be content to lag behind? The distinction made by H. G. Wells between the three "agglomerative" languages, French, English and German, and all the rest, is by no means so clear as he would have us believe. There is a long way between English and Catalonian, for instance: but all the links of a continuous chain could be found. Can we consider as a minor language Italian, with its magnificent literature, past and present, its active scholarship, its intrinsic beauty, its faith in its own destiny?[1] Or Russian, or Spanish, with their vast numbers, their great achievements, their boundless possibilities? The strong plea of the Brazilian delegate at the Hague Conference against the notion of secondary powers not entitled to all the honors and privileges enjoyed by a few applies with even greater force to the notion of secondary languages. Language has become such a symbol of racial patriotism that the balance of power is preserved as jealously in the linguistic domain as in the political.

[1] Cf. the activity of the Dante Alighieri Society for the spread of the Italian language.

The present supremacy of English in commerce is undoubted. Yet it does not amount to a monopoly. English has to face the rivalry of German in central and eastern Europe, of French in the Mediterranean countries, of Spanish in South America, of the native languages everywhere. When the commercial hegemony of England was absolute and apparently indestructible, England could impose the use of her language to all her customers. German competition has taught her that it paid to use the customers' own speech. The unique position of English is thus becoming a thing of the past. England and the United States may retain their lead and even increase it, but the days of monopoly are gone.

All things related to traveling—hotels, traveling agencies, navigation companies, were long the stronghold of Anglo-Saxon influence. But there is no sign that the *relative* importance of that influence is on the increase. A generation ago, only Englishmen and Americans had both the means and the desire to travel. The French were "casaniers" (stay-at-home); the Germans were poor, and all the rest, especially the South American "rastaqouères," were totally without prestige. The number of Anglo-Saxon tourists has greatly multiplied. Instead of limiting themselves to a few well-known resorts, they haunt every little corner in Europe. But they are no longer alone. German and French cruising yachts call at every port. Parisian hotels can not be content with the "English spoken" of yesterday. He who pays the pipers calls the tune, and we are beginning to hear other tunes besides "Rule Britannia" and "My Country, 'Tis of Thee."

We do not believe that any nation is going to wrest from England and America the scepter of the commercial world; we do not believe that Anglo-Saxon influence in that domain is on the wane. But we do believe that it is not likely to become greater than it was some ten years ago. And, since it was not sufficient then to secure the adoption of English as international medium, it probably never will.

Business is not the whole of life. If we turn to science, we find that, whilst English has conquered international recognition in practically all branches of learning, in hardly any does it rank first. England and America have as splendid a roll of scientists to show as Germany or France; but many of these were isolated men of genius. Germany has a larger host of conscientious, subordinate scientific workers and a larger *competent* public. The lead of Germany is probably not so considerable as some Americans are apt to think. This country has long been a province of the Fatherland as far as higher education was concerned, and it retains to the present day a pro-German bias which makes it unjust to the achievements of England, France, Italy, and even to its own. But, great or small, that lead, from the linguistic point of view at least, is undeniable. For the purpose of disinterested study, every

scholar and scientist in the world has to learn German first, and possibly French second. In this connection, again, the claims of Italian are too often disregarded in America, and yet there is hardly any branch of learning in which Italy is not doing excellent work. We had occasion, this year, in an English-speaking university, to use the Italian translation of a Danish work on the old French epic. This is a small but typical instance of the growing cosmopolitanism of science, and of the usefulness of Italian.

But, in the world of science just as in the world of commerce, the so-called minor languages show an increasing tendency not to recognize the privilege of the three or four now in possession. Berthelot complained that, whilst in his youth, with four modern languages *only* at his command, he could keep in touch with scientific activity everywhere, he could no longer do so at the dawn of the twentieth century. Science does not quite obliterate national susceptibility. Scientists work for their compatriots primarily. Perhaps they shirk the effort which the use of a foreign tongue always involves; perhaps they are afraid of the traps which the grammar of French, English or German is fenced round with, and in which even the wary may fall. Scandinavian, Dutch and Slavonic scientists still use the recognized world-languages occasionally in preference to their own; but there is a growing body of untranslated and often valuable works in Dutch, Danish, Swedish, Russian. The unification of scientific literature under German hegemony is fast becoming a dream, and English hegemony the shadow of a dream.

The position held by English in commerce, by German in science, belongs to French in the world of "polite culture"—diplomacy, society, art and letters. It is a well-known fact that this position is not what it used to be. William II. is an accomplished French scholar and an admirer of Frederick the Great; yet he does not cultivate the tongue of Anatole France as his ancestor that of Voltaire. The Gallophobia of twenty years ago no longer blinds Berlin to the merits of France, yet the Prussian Academy would not as in 1784 crown a modern Rivarol for an essay on the universality of the French language. There has been, almost everywhere, a sharp and often unjust reaction against French influence. The Belgian Flamingants have revived their neglected dialect, and secured for it absolute equality with French. In Rumania, where the Frenchification of the upper classes had gone to almost incredible lengths and was threatening to stifle the legitimate development of national culture, there have been actual riots against the "Bonjouristes." And the predominance of French in the Mediterranean is not so exclusive as it once was.

However, the position of French is much stronger than most Americans believe. America welcomes our lecturers, our actors; few colleges are without a French club, and even in small towns, ladies will meet

once or twice a month "pour parler Français." Yet, we regret to say that America, for whom we fought, America, our sister republic, is, of all great nations, the most indifferent to French culture. The small number of Frenchmen in this country, the bad reputation of a few international places of amusement in Paris—some under English management—a small, noisy literature exclusively for the Boulevards and the export trade, perhaps also the enormous influence of Germany, whose friendliness to France was none of the warmest—all these factors have led many Americans to neglect France, her people and her language. America was, I believe, the first great nation to restrict the use of French as the diplomatic language, and she is perhaps the only one at the present day where more students learn German than French.

However, in the rest of the world—for there *is* a rest of the world—French maintains its position. It is curious to notice that foreigners are much more sanguine than the French themselves about its future. At the Liège congress for the diffusion of the French language, a Russian, Novicow, led the optimists, against our great medieval philologist, Paul Meyer, probably lost in his regrets for the glorious thirteenth century. Rivarol was never more complimentary to us than H. G. Wells, Gubernatis, Valera or Max Nordau.

Professor Brander Matthews believes that the larger intellectual and financial opportunities of English will lure ambitious writers away from their language and their people. He gives Maarten Maartens as an example. This tendency is not new, and French, in the past, could point with pride to many such transfuges, from Brunetto Latini to Frederic of Prussia. And that power of attraction is not spent. For anything except a sensational novel or a volume of sermons, French offers at least as good financial opportunities as English, a more independent and better trained body of critics, a more open-minded, more discriminating reading public. That is why, not only in the days of Chaucer and in the days of Gibbon, but in this twentieth century of ours, so many foreign authors have adopted French as their vehicle. And not only critics and novelists, but poets—which supposes an extraordinary degree of familiarity with the language: Belgians of Teutonic origin, like Verhaeren, Maeterlinck, Rodenbach; Rumanians, like Bolinteano, Hasdeu, Macedonsky, Stourdza, Helen Vacaresco; Greeks like Parodi and Papadiamantopoulos (Jean Moreas); the Cuban Jose-Maria de Heredia, perhaps the greatest of them all; English poets—Swinburne, Oscar Wilde, Mary Robinson (Mme. Darmesteter-Duclaux); finally true-born Americans—Francis Viele-Griffin from Virginia, Stuart Merrill from Long Island, both doing excellent work:

> . . . J'en passe, et des meilleurs!
> Pour trois qui vous viendraient, il m'en viendrait soixante.

I do not mean to say that French is, or will be, in any but the vaguest sense of the term, the international language of literature. If a few writers may be led by the prospect of more rapid success, or merely for personal reasons, to serve under foreign colors, the majority will remain faithful to their mother tongue, great or small, for in it alone their best work can be done. A language spoken by five million men may be as good a literary medium as one used by a hundred and twenty million. Indeed, a Pole, for instance, might actually be better off than a Frenchman in many respects, for he would combine an intenser national feeling with a more cosmopolitan culture. It is possible not only to do good work in the so-called minor languages—most of which have a larger public than English in Shakespeare's time—but also to conquer universal fame. Russian is little known beyond its frontiers, yet Tolstoy is everywhere admired. New York alone has a much larger population than Norway, but Clyde Fitch's glory has not eclipsed Ibsen's. Sienkiewicz's country is dismembered, his language persecuted in Prussia and in Russia—and who has not read "Quo Vadis"? Mistral writes in a dialect, a patois, an artificial one at that, the combined work of the peasant and of the philologist; no one was surprised when the Nobel prize was awarded him. We do not see any tendency to a concentration of languages analogous to the Marxian concentration of wealth. But if there were any signs of such a concentration, they would seem to be in favor of French rather than English.

It seems therefore improbable that this tangled problem of international speech will be solved automatically, by a natural process of selection. One alternative remains to be considered: a universal agreement. There is a growing spirit of cooperation among nations, and so the adoption of a world-language is becoming at the same time easier and more desirable as time goes on. Latin was universal when there was a Roman world, Imperial or Catholic; classical French was universal when there was a "classical Europe"; after a century of division, the world is recovering the consciousness of its unity. Let us hope that a conference will be called together, and a universal agreement arrived at; what, in an open competition of that sort, would be the chances of English?

I waive the argument from the present erratic spelling of English. Professor Brander Matthews is doing his best to reform it. Let us hope he will fully succeed, that is to say, that English will be altered beyond recognition. Perhaps the difficult sounds of the language, its weird consonants, its tripthongized vowels, might also be eliminated. The present chaotic state of English accentuation calls for urgent reform. A "Simplified Pronunciation Board" would help us out, by making it a misdemeanor to pronounce English otherwise than in the scientific, or German, way. After such thorough overhauling, English

would stand a little ahead of French, and not too far behind Spanish, Italian or German in the way of logic and simplicity. But all that trouble would be vain—a tremendous trouble, since it would oblige the Anglo-Saxon world to learn its language anew. The qualities of English, not its defects, are the main obstacles to its adoption.

The *raciness* of English is its glory and its bane. There is no more strongly individualized language. On account of the very simplicity of its grammar, of its syntactical flexibility, it has more idioms, and is more puzzling to foreign minds, than either German or French. English is an admirable tool, plain, strong and sharp, singularly dangerous in unskilled hands.

The might of the English-speaking countries would be the next objection. The balance of power would seem to be destroyed in their favor. Germany could agree to the selection of Italian without loss of self-respect, or even to that of French, because there are, for the adoption of French, historical reasons which, at present, do not wound the susceptibilities even of the most sensitive nation. But to accept English would be to acknowledge one's own inferiority. The boastful tone of certain writers and orators, although that is fast becoming a thing of the past, greatly increases the moral force of this objection.

Finally, the English-speaking race is progressive, but on its own traditional lines; its literature is deeply human, but intensely national in its expression. The abstract, analytical character of classical French, the effort to describe "man in general," and to discover truths of immediate and universal application, are lacking in English. To this fortunate lack, English literature owes much of its depth and freshness, English thought its "congruency with the unutterable," English political life its wise compromises, its freedom from revolutions and adventures. French is essentially international. Patriotism has inspired French writers to compose admirable poems, and Chauvinism is, or used to be until quite recently, as rife in Paris as Jingoism in London. Yet the French language can be so completely dissociated from the French nation that the most abundant and the bitterest denunciations of France are written in French.

Once more, I hold no brief for French. I do not believe that it will ever be more fully recognized as international than it is at present. There are strong reasons in its favor, but none is decisive. And there are two great objections against it. It is the language of one of the world-powers, and international jealousy would prevent its adoption. Then its strongest claims are historical: but the new nations, America, Japan, quietly ignore European history. A tradition is not a reason; it loses all its virtue as soon as it is no longer respected. America refuses to be ruled by the shade of Louis XIV. We can not blame her. And I must say that, as a Frenchman, I do not regret it.

For our own experience in the eigthteenth century has taught us that universality is a mixed blessing, perhaps a curse in disguise. As everything must be sacrificed to perspicuity and simplicity, there is a danger of enfeebling the language, of making it colorless. It breeds self-satisfaction, and, by making the study of other languages less useful, it favors ignorance and one-sidedness. For many years, the French smiled contemptuously at whatever was not French. They are at present reacting almost too vigorously against that tendency; let us hope that England and America will escape both these dangers. The assumption of superiority on the part of one language and therefore of one race, of one or two nations, causes jealousy, diffidence, hatred. France had to pay a heavy price for her once exalted position. She had to convince the world that she was not in any way a menace before sympathy would flow back to her.

The present situation, with the curse of Babel still on our heads, is not, of course, incompatible with progress, national and international. With the diffusion of the study of modern languages, with the multiplication of translations—some famous works have appeared simultaneously in eleven tongues—with the growing international vocabulary of science, commerce and pleasure, the world feels more and more its essential unity. We can live and prosper without an international language; but, in the same way, we could have lived and prospered without the printing press, the railroads and the telegraph.

The problem remains with us, baffling and entrancing. We all realize what a progress it would mean if all conventions, societies, publications of world-wide scope, would adopt one world-wide language; if not diplomatists, scientists and scholars alone, but the business man, the social worker, the missionary, even the common laborer, had a simple, universal means of intercommunication.

We have attempted to show that through neither conquest, natural development or international agreement had any living language a serious chance of being accepted as international. But is there no other solution? Are we not substituting, in every domain, order for chaos, science for tradition, the organizing will of man for the blind arrangements of fate? Is it beyond the capacity of our scholars to select or in the last resort to devise, a perfectly neutral tongue? If French or English will not do, why not try Esperanto?

PERFECT FLOWERS IN MAIZE

By Professor E. G. MONTGOMERY
UNIVERSITY OF NEBRASKA

IN The Popular Science Monthly of January, 1906, the author wrote a brief article entitled, "What is an Ear of Corn," presenting some observations on the occurrence of hermaphrodite flowers in maize; this occurrence with other evidence indicating that maize had probably originated in some manner from a perfect flowered plant, while in all cultivated maize the flowers are strictly single, being either male or female. However, a comparative study of male flowers (from the tassel) and female flowers (from the ear) showed analogous parts in both. The tassel flowers in the older stages, however, are borne in pairs, while the ear flowers are single, but a study of the embryonic ears showed the male flowers to be twinned at this stage, but as development took place one of these flowers became entirely abortive and only one fully developed. Perfect flowers were also found in somewhat deformed plants, which looked in many ways like reversion in types. A study of the gross structure of the ear and tassel showed a close structural analogy between the ear (including cob)

Fig. 1. Hermaphrodite Flower of Maize (*Zea mays*) showing structural features (reproduced from former article).

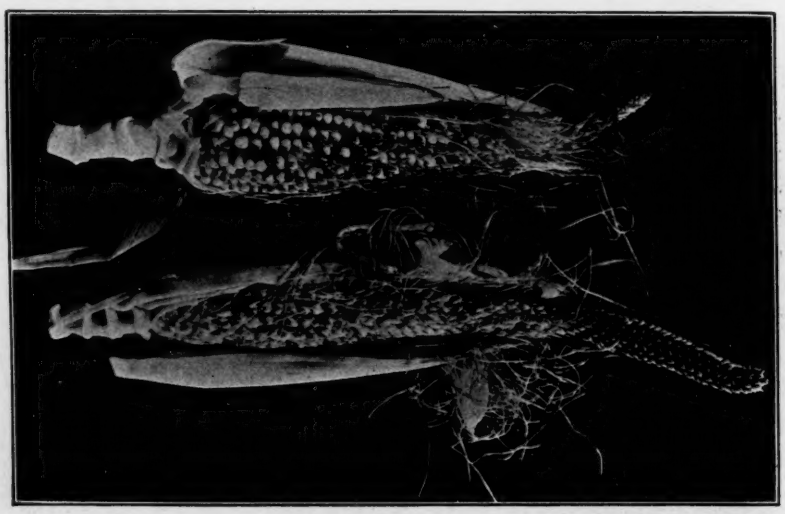

Fig. 2. Ears of Maize bearing perfect Flowers. These ears are quite young, *i. e.*, just in blossom. The mature ears averaged about six inches in length. Practically all ears of this strain came true to type.

FIG. 3. THE UNUSUAL TYPE OF PLANT, producing ears in Fig. 2, and which seem to be associated with the production of hermaphrodite flowers in maize.

and the central spike of the tassel, and strong evidence was found in support of the theory that the ear was a development from the central spike of the tassel borne on a lateral branch of the plant, the other branches of this tassel becoming abortive. Good examples were found of ears, showing remnants of these lateral tassel branches, confirming the above statements. At that time the author had only observed the perfect flowers in the very young stages of development and on more or less deformed plants. Fig. 1 is reproduced from the article referred to, indicating the character of these flowers.

Since then, types of corn showing this hermaphrodite flower on normal types of ears have been observed. Fig. 2 is an illustration of such an ear.[1] Some thirty plants of this were grown and all came true

[1] The seed of this was secured from Mr. C. P. Hartley, Department of Agriculture, Washington, D. C., who discovered the plant as a reversion in one of his breeding plats.

FIG. 4. EAR OF BOONE COUNTY WHITE DENT MAIZE, with perfect flowers. The ear was a very fine specimen.

to type. The ear was about six to eight inches in length and of normal appearance, except that each seed had three fully developed stamens, arising from near the base. The plant, however, was very peculiar in appearance, as shown in Fig. 3. The plants were about five feet in height, the stem short jointed, with broad leathery leaves, resembling tobacco plants as much as corn plants. Professor Emerson, of this station, has had hermaphrodite plants occur in several of his corn hybrids and in all cases they have had this peculiar type of foliage. If this type should be a reversion toward the primitive type it would be of great interest, since we have no grass plant at present having this appearance.

FIG. 5. CROSS-SECTION OF EAR IN FIG. 4, showing stamens at near base of kernels. Practically every kernel had three well-developed stamens.

Another most interesting ear of perfect flowers was found by chance in a lot of Boone County White Corn, secured from a prominent grower. This variety represents the highest development in modern improved corn. The ear in question was unusually large and well developed, as shown by Fig. 4, the ear weighing about 16 ounces. Fig. 5 is a cross-section of the same, showing the presence of stamens with every kernel. Fig. 6 is an enlarged photograph showing both sides of one kernel. On the anterior side are shown three well-developed stamens. On the posterior side, at the very tip and practically embedded in the cob, are three small stamens. These are the last remnants

FIG. 6. SHOWING BOTH SIDES OF KERNEL, FROM EAR IN FIG. 4. Three well-developed stamens shown on posterior side. On the anterior side and embedded in the cob were three rudimentary stamens, remnants of the abortive flower.

of the abortive flower, described in the former article referred to. This little abortive flower can only be found in the early embryonic stages of development, and usually all trace of its presence is lost except the extra pair of glumes on the posterior side of the kernel. These little stamens, however, indicate that at one time it might have functioned and give us another clue to some of the evolutionary changes that this interesting plant may have gone through.

THE SOUNDS OF "CH" AND "J"

By WINIFRED SCRIPTURE
BRYN MAWR COLLEGE

THE sounds "ch" and "j," as in "church" and "judge," have been represented, on the one hand, as being composed of two sounds, "t" or "d" with "sh" (in phonetic transcription *ts* and *dz*) and on the other as being single sounds (in phonetic transcription č and ǰ). Related to this is the question whether the Italian "c" and "g" before "i" or "e," as in "cio" and "gia," are more like "ch" and "j" or like the two forms of "sh."

Records of these sounds were made with a voice-recording apparatus (Fig. 1). This apparatus consists of a mouthpiece into which the words are spoken. The waves thus formed proceed down a tube to a rubber membrane at the end, making it vibrate. A straw lever is attached to the membrane with which it rises and falls in unison and so makes a record on a surface of smoked paper around a revolving cylinder.

Records of typical pronunciations of "ch" and "j" enable us to settle their nature definitely.

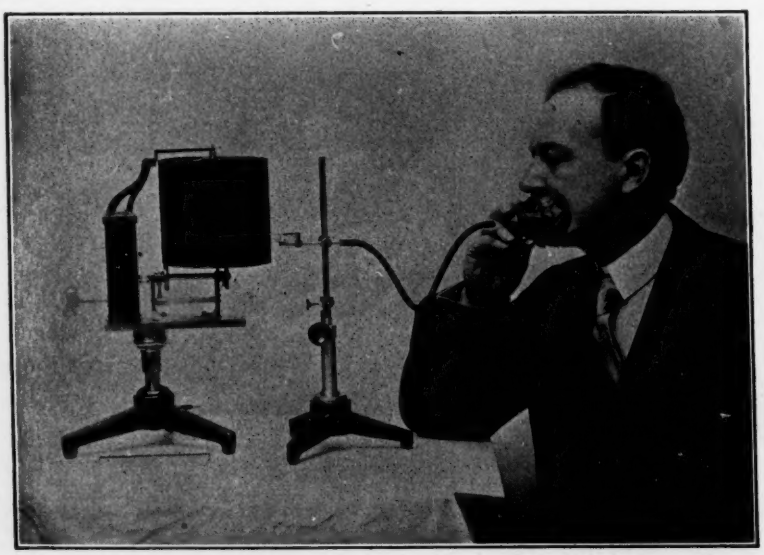

FIG. 1. RECORDING THE VOICE. The waves from the mouth proceed down the wide tube to the rubber membrane at the end. The vibrations of the membrane are recorded by a straw lever on a surface of smoked paper around a revolving cylinder.

A record for "Mitchell" is shown in Fig. 2. It begins with very faint vibrations for "m"; thereupon follow strong vibrations for the vowel "i." The straight line after the vowel indicates a complete stoppage of breath, that is, the sound is an occlusive. After the occlusion the line rises at first gently and then strongly, as the result of the stoppage being ended and the air rushing out rapidly; this phenomenon is called an explosion. The sound at this point is therefore an occlusive with an explosion. This is the sound "ch" which is indicated by the spelling "tch" in the word recorded. The word ends with strong vibrations for the vowel "e" and fainter ones for "l."

A record of the word "nut" by the same speaker is shown in Fig. 3. It begins with very faint vibrations for "n" followed by stronger ones for "u." The straight line indicates the occlusion for the "t." The strong sharp rise of the line indicates that the "t" ends with a sharp explosion. This explosion is quite different from the more gradual explosion of "ch" as shown in Fig. 2.

A record of the word "nutshell" by the same speaker is shown in Fig. 4. Very faint vibrations for "n" are followed by stronger ones for "u." The straight line indicating the occlusion of the "t" is followed by a very gradually rising line which remains for a time at quite a distance above the base line. This indicates that the occlusion of the "t" was not followed by an explosion, but by a continuous rush of air. This portion of the record is typical of the records for "sh."

A record of final "ch" in the word "atch" is shown in Fig. 5, a record of initial "ch" in "chew" in Fig. 6. Records of "j" differ from those of "ch" in showing small vibrations during the occlusion and the explosion. These are due to the vibrations of the larynx which are present during "j" and not during "ch." The "j" is said to be "sonant," the "ch" to be "surd."

These records and many others from the same person and from other persons (Americans) show clearly that the sounds "ch" and "j" consist of an occlusion with an explosion following it, that the explosion is more gradual than the explosion for "t" and "d," and that the explosion is of quite a different character from the rush of air during "sh." The conclusion is unavoidable that "ch" and "j" are not compound sounds, but simple occlusives with characteristic explosions.

By coating the tongue with ultramarine just before speaking, "ch" or "j" or by any of the other methods of palatography[1] a record of the contact of the tongue with the palate may be obtained. The regions of contact for "ch" and "j" are found to be larger than those for "t" and "d."

The final conclusion is that "ch" (č) and "j" (ǰ) are to be recognized as individual sounds quite distinct from the compound sounds "tsh" and "dsh."

[1] Scripture, "Elements of Experimental Phonetics," chapter XXI.

Records by a native of Potenza, Italy, are shown in Figs. 7 and 8. The record of "Mariuccia" begins with some very faint vibrations from the "m." These are followed by stronger ones for the "a." The

FIG 4. RECORD OF "NUTSHELL." The straight line showing the occlusion for "t" is followed by a rising line showing the rush of air for "sh." This is quite different from the curve for "ch" in Fig. 2.

FIG. 7. RECORD OF "MARIUCCIA." For "ci" there is no complete occlusion but a steady emission of air ending with an explosion. The curve differs from that of "sh" or "ch."

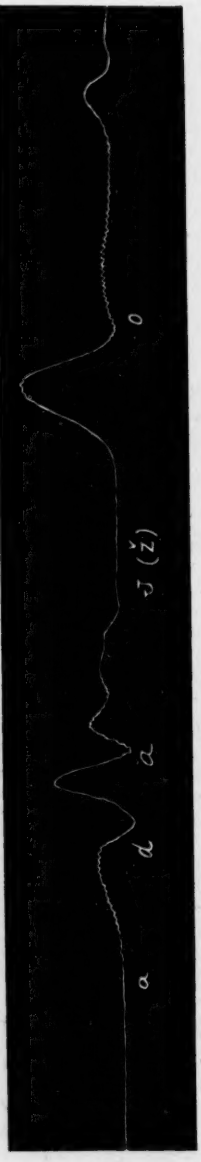

FIG. 8. RECORD OF "ADAGIO." The curve for "gi" shows an almost complete closure followed by an explosion; it is a modification of the curve for "ci" in Fig. 7.

sudden jolts in the line are the record of the two flaps of the tongue for the "r"; the small vibrations indicate that the "r" was sonant throughout (that is, that the larynx was in vibration throughout). Then follow the vibrations for "i" and the more open "u." The sud-

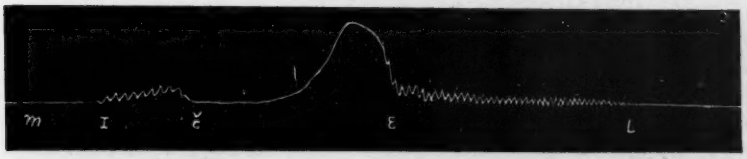

FIG. 2. RECORD OF "MITCHELL." The record for "ch" shows an occlusion with an explosion of a special form.

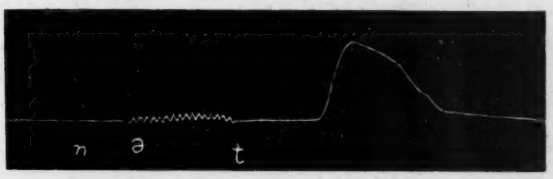

FIG. 3. RECORD OF "NUT." The explosion for the "t" is different from that for "ch" in Fig. 2.

FIG. 5. RECORD OF "ATCH" SHOWING THE FINAL "CH." The end of the occlusion and the form of the explosion are like those of "ch" in Fig. 2.

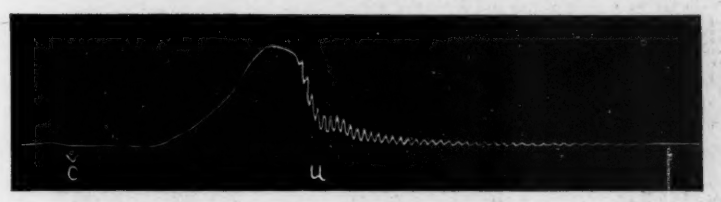

FIG. 6. RECORD OF "CHEW" SHOWING INITIAL "CH." The explosion of "ch" is the same as in Fig. 2.

den descent of the line after "u" indicates that this sound was cut short by some closure in the mouth, namely, by the tongue action for the sound "c." The line, however, does not remain at zero, but rises gradually; this indicates a steady emission of breath and not a complete closure. The partial closure is finally released and the explosion is registered in the sharp upward movement of the line. The sound "c" thus shows a sharp explosion like that of "t" but an incomplete closure. The closure is much greater than that of "sh" and the emission of air is much smaller (Fig. 4). The Italian soft "c" is therefore not an explosive occlusive like "t" or even like English "ch"; it is not a fricative like "sh"; it might be termed a fricative with an explosion. At any rate it is a distinct sound not existing in English.

The record of "adagio" begins with vibrations for "a." The first downward movement of the line corresponds to the sound "d"; this ends with a strong upward movement due to the explosion. Thereafter follow vibrations for the vowel "a." The nearly straight piece of line with faint vibrations is the first part of the soft "g"; it is almost but not quite an occlusion. It ends by the strong upward movement of the explosion. The record ends with the vowel vibrations of "o." Other records from the same speaker show even less occlusion through the soft "g." We seem justified in concluding that soft "g," which is the sonant corresponding to soft "c," is, at least in this part of Italy, not identical with the English "j."

THE RELATIVE IMPORTANCE OF MENTAL PAIN

By SMITH BAKER, M.D.
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IT is everywhere thought beneficent and just to recognize the demands of physical pain, and to furnish prompt and effective means for its relief. Let there be but the least significant crick or colic, the dullest ache, the most transitory throb, and it is almost universally considered uncivilized not to try to give the sufferer relief from such an intrusion upon his sense of comfort and safety.

When, however, we look at the other aspect of human suffering, the one that is much more closely intimate, and yet much less evident to observers—the psychical, the mind-and-heart side of mortal suffering —we come upon the interesting if not startling discovery that there has been, and still is, comparatively speaking, by far less attention given to the truly exceptional needs of this kind of suffering than to those of physical derivation, even though so frequently these latter are of the lower order and of the lesser significance.

Of course, it should not be inferred that the significance of mental pain has never been recognized, nor that useful attempts at amelioration have never been made. Quite a proportion of the work of the sympathetic and other helping classes has ordinarily been and is now in some way to comfort and encourage and otherwise mitigate and even cure, the mental distress of their fellows. Moreover, it can be joyfully conceded that the sick-room has always and everywhere been the scene of useful effort on the part of the more strictly professional classes, through sympathy and persuasion and cheering-up and every other sort of constructive and kindly attention, to relieve the sufferer from everything which might add mental distress to his physical ailment. All this has been worthy, most useful, even though as yet it may be counted chiefly as but a sort of foundation experience upon which real systems of relief shall be built, those which shall certainly be far more truly and widely successful than hap-hazard methods have hitherto proved.

But granting all this to be true and as praiseworthy as useful, it still should not appear to be far-fetched or intrusive once more to invoke still further consideration of the relative importance of mental pain, or confidently to express the hope that in the very near future the extent and depths of this shall come to be by far more adequately recognized and appreciated; and that the art of preventing and ameliorating this shall be considered as much a matter of simple duty,

as has been or will continue to be the art of preventing and relieving pain that is distinctively physical.

But first, what is "mental pain," or "*psychalgia*," as it may better be called? What evidence have we that aside from some form of physical pain there is ever any such thing as "psychalgia," that is, something which can be more familiarly and supposably more clearly noted and described than heretofore, and consequently more satisfactorily dealt with? If present how are we to differentiate it, and thus be reasonably sure that we are not dealing with mere phantoms—something that is not fixable or definable, and not to be rationally handled in any way?

Probably no one can truthfully say that there is such a thing as mental pain who has himself never suffered from it, and at times when physical pain or distress has not been present to such a degree as to obscure or complicate self-observation, beyond differentiation. For, no matter how dire the psychalgia in the latter case, the suspicion must arise that it was but merely a *quale*—quality—of the physical condition, and so not susceptible of being considered as a distinctive kind of suffering at all. To be this and to be worthy of consideration as a true psychalgia, it ought at least to be capable of being consciously remembered as an experience by itself, dissociated somewhat clearly from every physical condition save that of general well-being, and in most cases, at least, of being referred back to certain causes, which, whether true or not, are consciously regarded by the sufferer as having been of distinctively mental origin.

By way of attempt at elucidation of this requirement, let us consider instances where the psychalgia, instead of being an exclusive experience, is apparently the direct consequence of personal shock and stress, and where primarily there are various wide-spread physical changes, especially in the sphere of metabolism, all of which must be included in any truly scientific consideration of the subject. To the sufferer himself these physical changes are of little importance, except as they are explained to him as possible sources of his mental distress. To him, it is his *mind* that is distressed, not his body: for the time being, all his regard is monopolized by his psychalgia, and if not told otherwise, he may not even suspect that anything but his mind is or ever will be affected by the causal event. If he be introspective and at the same time analytic enough, he will chiefly or exclusively note that his mental horizon has become painfully restricted; that his ideation is being painfully overworked along some certain narrow lines; that his emotions are all suffused with pain, even paradoxically when little or in nowise disturbed; and that his outlook upon the future is simply too painful to be invited or prolonged. In fact, it becomes evident that all the pain which the sufferer experiences is referred to his mind

as something distinct from his body, and is there, and only there, to be met, handled and helped, if possible. "Give me relief from this awful feeling of inadequacy—from the pain that accompanies every thought—from the dark that clouds all the future. Please do this, and I will be well," is the cry: and to the sufferer this is all there is that can be described or helped.

Of course, psychalgia may accompany or succeed every form of physical distress imaginable; but even here, it is characterized by the very same consciousness of intellectual inadequacy and underrating, of emotional unrest instability and depression, as well as persistent vision of future blackness, as elsewhere; and has corresponding need to be regarded and dealt with, so far as possible, as distinctive from the physical distress present.

With these leading characteristics of psychalgia in mind, suppose, by way of still further helpful elucidation, we investigate and follow the course ordinarily taken by a case of so-called "traumatic neurosis." Here there are, especially at first, clearly outlined localities in the organism whence waves of purely physical distress emanate, whose origin can not be accurately referred except to their organic source. But in time these come to be associated with certain other waves of pain, whose localization is not so apparent, either to the sufferer or to the investigator. In fact, eventually a large proportion of the suffering of the patient is seen to consist in pains which have no locality outside the selfhood that has been so direly and so deeply insulted by the injury. Often, too, because of supposed blundering on the part of his own self, or rebellion at "fate" through consideration of his present predicament in connection with previous experiences, or of vengeance against the objective cause of his present trouble, or of fear of possible untoward consequences, or of changes in intellectual strength and acuteness, emotional tone, will-power, self-control or self-direction, there comes additionally an abiding, ever-deepening sense of degradation, which eventually enshrouds him in distress that seems as coextensive as consciousness itself and as intense as imagination could possibly picture. Surely, if we have no means of absolutely differentiating the psychical from the physical pain—the *psychalgia* from the *neuralgia*—we are nevertheless not precluded from recognizing such differences at the focal points of the two kinds of distress, as to lead us rightly to deny that these may possibly require very different kinds of estimation, for the highest good of the sufferer. In fact, while splints and plasters and lotions and doses may succeed admirably in relieving the *physical* consequences of physical trauma, it should not be forgotten that the accompanying *psychical* trauma is of another order, and has very different needs, as to both estimation and remedy; and this, no matter how clear may be our notions as to the physical distress, or how this may contribute simultaneously to psychical distress, as well.

Or, take a case of developing melancholia, where again the physical and the mental seem to vie with each other in the slide downward into abject misery. Here the defective metabolism, the choked secretory and excretory functions, the muscular weakness, and all the rest, are sufficient in a way to explain the mental condition as represented by its own peculiar slowness, weakness and distress. But however much and clearly these may "explain" to the observer, they most certainly do not constitute the pain which is really suffered—the morbid self-consciousness, the overwhelming depression, the fear of self-destruction, the dissociation from the rest of humanity—in fact, the poignant psychalgia, for which only personal experience can afford correct knowledge or provide the data for anything like a correct description. To all such, psychalgia is a definite, horrid fact, not to be mistaken for any other fact in the universe.

Take again the perplexing development and especially the slow systematization of the inner experiences of the youthful hebephrenic, or paranoid. Beginning with scarcely recognized perversions of one or more sense functionings, or with weakening or perversion of the more elaborate perceptional or ideational activities, the victim duly comes to the point where everything persistently clusters about his inner self, progressively to lead on to perplexity or danger or failure, with all the poignant mental distress that naturally belongs therewith; so great distress in fact, that long before such a state of self-monopolizing is reached, there is a period during which mental pain is so predominant that often some sort of real physical pain may be welcomed as chiefly beneficent. Surely, no one can suppose that the weakness, the muddlings, the suspicions, the fears, the antipathies and antagonisms, the imperative insistences and explosions of such an one, can be confounded with any sort of physical pain whatever. Here, as before, psychalgia is felt to be a fact, distinctive, dominating and determinative.

This leads logically to the consideration of the by far largest group of psychalgias, those derived from the so-called "border-land" cases on the one hand, and from the great number of persons who in no ordinary sense are "cases" at all, on the other.

Abnormal psychology has yet an imperative need to be studied as never before, and this notwithstanding the far-reaching revelations and suggestions of more recent investigators. In this undertaking, introspective psychology, prosecuted by the right kind of self-observers, can become of such profound use, that almost everything as yet discovered may turn out to have been introductory, to say the most. Probably, there is no one who has been trained to properly look in upon himself, who does not have more or less frequent attacks of psychalgia so clearly defined, that were they accurately observed and recorded, a key would be furnished whereby not only the problem of his own morbidity could

be solved, but also a standard could be established whereto similar morbid experiences of others could be profitably compared.

From cases of border-land psychalgia we often get descriptive phrases which throw light upon the intensity of the suffering, and leave no doubt as to its reality, as well. One of the most frequent of these phrases is, "Oh, I am so lonely—(or fearful, or depressed, or weak, etc.) —this unceasing, day after day, year after year, loneliness—etc." Here, as much as anything, for want of the simple instruction that as the "uniqueness" of any given individual must always carry with it a fundamental detachment from every other individuality, so must necessarily a natural loneliness reside forever in the substratum of every one's consciousness, and must normally or abnormally emerge only as endurable pathos, on the one hand, or as dire pain on the other, the sufferer necessarily goes on day by day accumulating a feeling of out-of-the-world-ness which in time gets to be so painful, that the all of life may and often does come to be subordinated to it, entirely beyond self-emancipation. Surely, it were not humane, to say nothing of its not being good sense, or scientific, simply to ignore or scout the evidence of, or to jeer at, or malign, or to continue to misunderstand the distinctive importance of such a condition of suffering as this.

Again, there is the expression, "Just show me how I can have a little bit of happiness, even for an hour, and I'll bless you as never before," and all the changes rung on this, everywhere and everywhen. For purposes of truth it must be conceded that a reasonable amount of frequently recurring happiness together with the ever-present feeling that such experiences are truly prophetic of the future, is simply a basic necessity to the perpetuity of a reasonable state of well-being; and this in spite of Carlyle's demand: "By what act of Parliament was it decreed that Thou shouldst be Happy?" The simple fact is, that all energizing, all hoping, all accomplishing which does not have an inspiring element of happiness in more or less conscious suffusion, is not satisfactory, but the reverse; and this, notwithstanding so much seems directly to the contrary. Happiness of some kind—positively ecstatic, mildly expectant, a glowing interest, realistic energizing, comforting self-consciousness, vision of growing possessions, personal ease, enlargement of the family circle, faith that sees heavenly things—happiness of some kind, is the motive force of human life; and once let the enjoyable self-tone be lowered unduly for any length of time, or its rightful possessor be too frequently or too permanently cheated or denied, and he ceases at just this point to be fully what he ought to be either by divine right or by natural law. And the consciousness of all such cessation of full-well-being—how many degrees of psychalgia are included therein! And how wide-spread too is just this same consciousness of every other form of unhappiness, with never a respite, and with no encouraging prospect.

And then, there is "disappointment"—in love, in business, in politics, in health, in preparation for life, in church affiliation, in children; disappointment in man's sense of honor, in woman's high soul, in the constancy of friends, in all ambitious prospects—for which we so glibly say, "show thyself a man," or "wait patiently on the Lord"—and think that we have said it all; and so we probably have, until we, in turn, direfully find ourselves learning very differently, through what our would-be friends call just our "own doing." Then, how different does pooh-poohed disappointment seem; how revelational, too, in that now we can see how others did actually suffer while we were regarding them as merely "weak" and consequently as but "poor things," at best. Nor does it matter really, if "one has brought it all on one's self"; indeed, all the more should we see how much does this but add to his distress, and how much does it have to do in prolonging and deepening this indefinitely; indeed, until it may most unexpectedly result in such permanent registerings, as may quite absolutely unfit him for any further useful accomplishment in life. For, first and last and all the time, it must be remembered that the outcome of psychalgia, unless acting upon exceptional constitutions, is *unfitness* for even the commonplaces of life. Of course, the exceptionally endowed individuality reacts differently, at least for a time, and for the most part, constructively; but the common cry of the victim of mental pain is, "I no longer can do as I once could; I'm not really fit for anything now"; and his subsequent life is apt only too conclusively to prove the correctness of his cry, and the predictive fear which accompanies it.

Morbid "self-consciousness," too,—how wide, vague, mysterious is this, yet how fearfully painful, especially when subject to misunderstanding, neglect, or brutality. Shall any one say that here is something that is not a source distinctively of the most interfering if not destructive kind of psychalgia? Try to get a definite appreciation of the flashy personal commotions, the wide-spread vaso-motor reactions, the stage-fright, the unaccountable antipathies and fears and obfuscations and general overwhelmings, that such a one suffers from; try to get a clear vision of all the futile efforts of intellect and feeling and will to ward off and overcome these; try to get a fellow-feeling of all that this means to the personality which would be something and do something and feel something like other people; and then see if it be possible to regard mental pain as less significant than physical pain, either distinctly, or side by side. Certainly, no one who has never suffered the pangs of morbid self-consciousness should stupidly deny their existence; for there are many, many people who go through life virtually conscious of nothing else, in any vividly continuing sense. With every glimpse of their own bodies, with every movement, with every contact with others, with every thought of planning or doing anything, with all their hopes

and realizations, there is such a tormenting intrusion of painful self-hood upon consciousness, that a desperate fight for place and favor, or even for existence, is always on, and the issue seldom if ever comfortably assured. Such people, in no sense technically "insane," are yet so burdened with a veritable soul-pain, that it is only a "kind providence" which for the time being keeps them from becoming unbalanced —a providence, however, which may yet some time call very loudly to any one who happens to be at hand, to come to its help against this "mighty" scourge, and all the indecisive conflicts which are part and parcel of it.

Undertaking now a yet closer study of this widely prevailing sickness of soul, expressed in so many morbid variations of consciousness, it does not take long to come upon the truth that probably the greater proportion of these cases are primarily owing to the fact that the personality itself has never from the first been properly harmonized, that is, has never become thoroughly enough blended in the course of its development to avoid remaining other than a veritable storm-center of all the ragings of emotion and ideation and volition, which are here as incalculable as they are pain-producing. Whether this unblending is due to such disparities and tendencies in the several ancestral lines as do not admit of continuously close relationship and coordination, even in distinct individuals, or whether the course of "bringing-up" from birth onward has been such as never to overcome the natural heterogeneity of the personal elements, probably common to the genesis of every human being, does not matter.[1] The outcome, a heterogeneous or imperfectly blended or ununified personality, may almost everywhere be discovered as constituting at least a very natural soil in which rank psychalgias may easily generate and grow and forever plague and choke the possessor quite beyond description. To stand on the brink of a seething surging crater, whose sulphurous fumes never cease to stifle, and whose eruptions are always immanent and frequently realized, might afford some sort of parallel to the position occupied by some of the more deeply afflicted of these cases; only, the man by the crater might possibly recede from his danger at will; while no Prometheus was ever chained more absolutely beyond self-help to his Caucasian rock, or was more horribly subject to tormenting insults both from without and from within, than is the one who finds himself inseparable from the miseries of the species of psychalgia that are chiefly due to heterogeneity, or to this in combination with all the imperfections of our natural growth and conventional breeding.

[1] See Smith Baker, article "Heterogeneous Personality," in the *Journal of Nervous and Mental Disease* for September, 1893; also article "Causes and Prevention of Insanity" in THE POPULAR SCIENCE MONTHLY for May, 1899; also William James, in "Varieties of Religious Experience," p. 169.

Speaking of "soul-sickness," brings to mind the subject of "religion" in all its bearing upon the consciousness of well-being or ill-being, and the profound interest, comparable to the acknowledged importance of the subject, thus insured. Formerly, certain classes of people at some particular times in their lives would come more or less unexpectedly to a more or less vivid and painful view of their sinful selves; then, perhaps for a longer or shorter period, would go through a series of spasms and stresses of conviction and renunciation and pleading and aspiration; but would in time "come out" of it all so victoriously, that usually forever after God was felt to be so good and so near that "salvation" and the "joy in the Lord" thereof were more or less fully assured forevermore. Along with these fortunately "converted" people, still other classes also have quite naturally experienced such a sufficient "assurance" of their "call," that they have quite uninterruptedly found ample solace for their untoward depression and apprehension, whenever needed. Thus, heretofore, many people have actually found, that when attacks of mental pain came on, they could go unreservedly to the "fount of all mercy" and find what to themselves, at least, was satisfactory relief. Indeed, whatever criticism may be justifiable with respect to religious dogmas and institutions, it certainly is not wise to forget that the human personality everywhere has recognized and does still recognize a supreme worth in its religious consciousness, and has found and still finds its profounder weal or woe in the spirit of religion and the practical exercises inspired by this. Woe indeed is it when religious fears and apprehensions and the general gloom arising from an abiding sense of detachment and loss, comes to pervade all the soul-life and simultaneously sees no or little relief. Joy indeed, too, when relief does come, or when the general religious temperament or atmosphere or experience begets the "joy that abides," in true realization of the Source that is Infinite! It does not do for even the most clear-sighted materialist any more than it does for the most devoted metaphysician, to forget that this deepest-sounding and farthest-reaching of all vital experiences may through mental or other pain come to be but a mere travesty of the *real life,* or that such abject misery and this only may irretrievably "damn" the subject long before the pains of future perdition are possible. "Hell on earth" is not a figure of speech to very many people; it expresses exactly the sufferings of those who are the victims of the sort of psychalgia which is owing to perversions and failure in their religious life.

A concrete case of associated mental and physical distress, occasioned by a succession of experiences certainly not very common, will serve to make plain not only the comparative significance of the more intimate kind of experience, in a way that can not be mistaken, but also somewhat to elucidate the blundering and inefficiency to which sufferers of psy-

chalgia are, let us hope unwittingly, everywhere subjected, chiefly because of failure to recognize its distinctive characteristics and needs.

The lady had reached middle life before anything other than unrealized motherhood had noticeably hindered or marred her fortunes. Then domestic troubles, loss of property, major operations came to shock and strain her in quick succession; but even these had she surmounted bravely and successfully; only, however, to develop in time the insidiously undermining of muscular control and all that goes with it, known as "Parkinson's disease." After this had reached an observable stage, it was evident that she had before her, not alone many long years of suffering from her tired painful ever-pulling muscles, for which there was no known cure, but likewise an ever-increasing danger from intercurring diseases and accidents, which could only be averted by constant care. But worse, much worse than all this, there was the horrible prospect that through it all her intellect was to remain as clear and the sensibilities as keen as ever, and that until the very last she must necessarily be the cruelly enforced observer of the entire course of most fiendish progressive physical decline. In fact, pain of body and pain of mind were to be in closest concomitance throughout. Already she had been partially apprised of the nature and cause of her disease; yet had evidently allowed herself to expect a more or less positive denial of this. But the facts were unquestionably against every view save that of unqualified affirmation—to be softened, however, as much as intelligent sympathy, general hopefulness, and patient care could make possible. Especially was it thought additionally desirable to endeavor to instruct and encourage her in the art of keeping her mind as rightly occupied on matters outside herself as possible; and also by suggesting a variety of means for combating the awful waves of depression and despair which had already begun to pass over her battered feelings and were sure to come with increased force, later on. After a month or so of this, during which time she had gradually become more fully acquainted with the true nature of the fight that was before her, as well as with a number of really useful measures for temporary relief of changing symptoms, especially those evidencing the "sick-soul" which would undoubtedly be the ground of some of the most poignant of her sufferings, she seemed vastly better prepared for her prospective ordeal, in that she had seemingly conceived and adopted the large and comforting assurance, that come what would, she would "make the best of it," and persistently remain all she possibly could be to the relatives and friends in whose circle she was to live.

Soon after this, however, she fell in with a member of a coterie of "faith curists," who assured her that she had no need to go through all that had been hinted, if not predicted, but could most certainly be "cured" simply by prayer, if only she would allow them to take her

in hand. Doomed as she otherwise rightly thought herself to be, one can not very consistently blame her for avidly grasping at the promised salvation, given with such assurance, even if from no matter how really unknowing a source. Submitting both honestly and unreservedly to the efforts of the "prayer circle," she seemed to "get better from the first," and, some two months later, it was noted that she could actually carry herself with somewhat better step, with a brighter face, and most of all, with the absolutely unembarrassed confidence that "before long she would be entirely well"; for "God can do anything, as you see." One could not be entirely dishonest in feeling much of the gladness with which she was congratulated upon her improvement, or in expressing the hope that this would continue indefinitely; yet, within, one could not help anticipating none the less clearly the fateful day of abject sadness and despair which would surely come to her, when she had all too pathetically found herself disillusioned and her physical disease quite perceptibly advanced, as well. One could indeed feel glad that she had had this much respite from her mental distress; but when one thought upon what ignorance of the facts, upon what fanciful assurances, upon what perversion of the highest offices of even present-day possibilities, her temporary release from suffering had been founded, one at least wondered if the temporary "gain" would in the long run be worth the irretrievable loss of confidence, true faith, and reasonable hope that was sure to ensue. Better, it seemed, that she should have patiently continued from the first without deviation in the persistent course of mind and soul cultivation and strengthening which had been marked out, or better still which might have been marked out, had some one more capable been her adviser, than to have experienced a but specious exaltation for a season, only to fall into the direst slough of despond, suspicion, digust and what-not, as she in due season must and did. From this awful jolt in her mental life she had better have been saved, so it seems even yet. Although what a thought significantly follows; if only she could have been given the comfort without such a train of miserable consequence!

After spending several weeks or months with this sort of people, and, more consequentially, after having given them all her little savings as well, and then found them mostly "uninterested" afterwards, she returned to her home where for more than seven years she divided the slow days and tortured nights between all the horrors of the deceived, the disillusioned, the despairing, on the one hand, and the bravest endeavors imaginable to endure patiently everything, and likewise not to become too rebellious against God and humanity, on the other. And during this period what a transformation physically, was hers. Slowly, step by step, ordinary communication with every one came to be cut off; while all their sayings, doings, feelings and entire lives yet remained as patent to her as before. Then eventually came the hour when not a

smile, nor a finger clasp, nor a syllable could she give, in token of her recognition of the life about her. For a couple of years or longer the only expression possible was through her clear eyes, which always seemed to be automatically trying their best to tell how truly their owner responded, really if not voluntarily, to every effort to communicate with or to help or sustain her imprisoned spirit. Once in a while an explosion of meaningless laughter, so unlike the laughter of her former self, would startle one with its unexpectedness as well as quality, but would carry little or no meaning, as only exceptionally would there be any such response to the pleasantries (which it was remembered she formerly rejoiced in) as would suggest that impression and expression had remained very closely associable. Indeed, it was obvious enough that she had now become only a bundle of impressionable tissues, organs and centers, never so keen as now, never so liable to insult, never so pitiable; simply—was now practically helpless in body—yet absolutely as active in mind as ever. Not disembodied, but body-burdened, was her soul to continue through all these months, to see on, hear on, taste on, feel on, think on, hope or fear on, rebel or acquiesce on, love or hate on—but always to be increasingly conscious of the body that was dying, dying, yet ever alive to ache, to hinder, to endanger! With Dante how truly could she have said,

I did not die and I alive remained not.

Yet, to those who were closely about her, to the great world that but little more than heard about her, even to those who were under obligation to interpret as truthfully as possible, it may be doubted if any one ever got more than an inkling of the great mental anguish or even physical distress suffered by her, until she herself as pathetically as surely made it known. Assuredly, the manner and speech and life of the household and neighborhood did not evince much beyond commonplace understanding sympathy and effort. And as the most interested may now look back upon his own thought and care of her, how paltry, too, how inefficient, how bungling, compared with what it ought to have been or might have been, does it all now seem!

And so all had waited until, in spite of everything—in spite of the greatly augmented sensitiveness of impression, in spite of the locked-up systems of expression, in spite of slowly entombing fate, in spite of inner travail, pain and unhappiness—had waited until this most pathetic sufferer conceived and perseveringly gave to the world, what probably is absolutely unique in letters, and better than this, even, something which may possibly be so pondered by all who have to do with human suffering of any sort of the locked-in kind, that to the end of time the human heart universal shall be the better for her effort.

Imagine her then with but the slightest power of denoting her wishes, and this with uncountable bunglings and failures, sitting at her

table, perhaps tied in her chair, with a series of baby alphabet-blocks before her. Her attendant opposite tries to make out what is wanted. Over and over again nothing is determined. Then it slowly dawns that she hopes to use these blocks to make known her wishes. Then, again, after weeks of trial, it is learned that she wishes to write a letter. But what a task is before her and her interpreter. Evidently, as it is not a commonplace communication that she wishes to make, the ordinary words and phrases must easily fail. But how difficult to be sure when the right letter or word or phrase is reached; even her simplest thoughts and feelings, to say nothing of the great determination in some way to succeed in more complicated expression, is so impossible. But slowly, with patience that should be crowned by all the Academies—slowly one by one, letters, words, phrases, sentences, even unto as many as eight note pages, and requiring as many as two full years or more to do it, was the precious revealing letter evolved—to be read in two minutes, to be forgotten—never! A letter so *intime*, so exceptional, so precious, that as a voice from the tomb did it come; as an appeal from the innermost soul of humanity, should it be received.

Nothing but the dire, infinite needs of the suffering soul of humanity's very self could justify the publication of such a communication; yet the justification is complete, when once we think of all the many selves that are everywhere suffering, if not from living entombments, then from death-in-life psychalgias, which if not physical are yet not the less horrible, and have similarly day by day through all time so absolutely to feel the great need of accurate recognition and efficient ministering.

Beginning our use of this letter at about its third page, she says, "While I look at the ceiling I see beyond and live in a world of thought and imagination. I take journeys, make visits, write letters—am like a live spirit in a dead body. Though I seem to be dead and irresponsive, I feel as if I were made on the principle of a toy jumping-jack, with some one pulling the string, holding my head back and mouth open. I must be a repulsive-looking object," she continues. "I must look like a fool, anyway." To one who had known her even when but partially well, and had noted her most delicately feminine appearance and ways, it is only too clear that observation of the successive steps of her progressive physical degradation was not among the least of the sources of her mental distress. "My throat and mouth are in dreadful condition. . . . My tongue refuses to work. My teeth all seem to be dying like the rest of my body. My tongue has grown short, I can hardly get it outside my mouth." No wonder that her next words are these: "I suppose books tell you these things I suffer and endure, but that little innocent word 'helpless' must be lived to know its meaning and misery. Add speechless, and the trifles of daily living become mountains of trial." And now

hear the deeper revelation: "One is misjudged," she says, "misunderstood, called unreasonable, when, if I could explain, it would be the other fellow." And how full of suggestion for all: "This life of inaction and repression is full of misery. It is only with the thought of putting yourself in her place, can one get any idea of the awfulness of living in a body that refuses to do anything for you." Ah! that thought of putting yourself in her—in any one's place. What a field of enlightening, constructive imagination is here, always. "I never dreamed of such a combination of conditions and circumstances of physical suffering for one to endure," she continues. Nor was the mere fact of personal suffering all; for she so regretfully adds, "I drink my cup of poison every day, and give a portion to every one around. It is awful to live and be such a disagreeable burden. I am like a lead sinker around—[her husband's] neck. It would be easier if I felt sick and weak; but I feel all the springs of life and energy to be and do." And how the realization of soul-body anguish deepens as one reads further; "People think I am comfortable when I am quiet; but I can not be anything else. I can not move an inch, no matter how cramped I am, or how things hurt. My suffering is constant and its name is legion." Yet, in spite of all this, note how characteristically it was to be added to: "Father [her father-in-law, a fine old man who had constantly, lovingly cared for her all the days, for years] has gone home [*i. e.*, died] and left me adrift on a sea of helplessness and silence. I suffer for want of him every day. He had grown into knowing my needs as no one else could. He was hand, feet and tongue for me. It was a sore trial to him, but he was ever sweet and patient. He filled a large place in the house, and it seems very empty without him. His was unquestioning trust, child-like faith, and so free from criticism of others. He was a lesson to us all. Oh, we felt so sure to trust him." How satisfactory in every way, that so much of this letter is devoted to such an appropriate tribute to devoted efficiency and kindliness. "When you were here in May you asked me to write you a letter. I wanted to tell you there was one in the mill, but that it grinds slowly." This was probably two years or longer before surprise at receiving it came. Going back to an earlier portion of the letter, written probably about the time of the asking for it, she says: "I dread spring and summer. If every day were a zero-blizzard, conditions would be easier to bear. When all the world is alive and stirring, it is harder to hibernate. In my corner, tied hand and foot and tongue, I am like a rat in a trap—the only thing left to do is to squeal"—a pathetic bit of the native humor which when she was well had ever irradiated her whole life.

Finally, to show how clearly appreciative she was, how inwardly responsive to even such poor desultory effort as was doled out (too often when most convenient, one fears), and especially to suggest how if a

system of recognition and care more intelligent, much more devoted had been employed, so much more good could have been done, let the conventional veil of sacred personality be removed from the very beginnings of the letter, and thus complete the picture as contained in its entirety: "I can only thank you," she begins, "for all your generous thoughts and deeds." Carlyle's remorse at his meager treatment of his "poor Jeanie" comes deprecatingly to mind as one now reads this again. "You are say-well and do-well bound in one frame."—What one ought to have been and done, rather. "Your Christmas book came; it was full of words of comfort. I have written to you in thought many times; it requires heroic effort to make it real. The lovely flowers spoke of you many days after you were here. It will soon be time to think of your coming again—always good to see you, and have your presence."

Unquestionably this is too personal to be published except for one reason—the immeasurable reason for calling attention anew, and with all the emphasis possible, to the need of a more universal recognition of the thickly peopled realm of psychalgia—the mentally anguished, the sick-of-soul—as well as to the never-lessening need there is of finding ways and means for more successful amelioration of such suffering, and of applying these with an efficiency heretofore unattempted. How often has one in the presence of this unique sufferer, as has been the case in the presence of many another less distinctive, felt an utter unpreparedness for rendering the relief which instinctively one has felt to be needed. Yet note how she understood, magnified and appreciated what little one did attempt. Could one have been intelligent enough, skillful enough, sympathetic enough, and could those in more immediate association with her have been similarly endowed and prepared, what indeed might not have been done to relieve, if not the bodily suffering then the mind and heart suffering, which was ever so present and so insulting.

LANGUAGE STUDY AND LANGUAGE PSYCHOLOGY

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IN The Popular Science Monthly for June, 1907, Professor Alexander Hill, the master of Downing College, Cambridge, contributed an entertaining article on "The Acquisition of Language and its Relation to Thought." What he had to say about the proved value of the study of Greek and Latin sounds like a brief for the classics, and ought to be more valuable as testimony than the arguments of any professed classicist. It is thus that Presbyterians who value tradition are fond of quoting Dean Stanley's admission of the priority of their system of church government. So I am fond of quoting one of my candid colleagues of the anti-classical battalions, who admits that much first-year laboratory work in science is as valuable, educationally speaking, as dish-washing. But, after all, the conclusions of Mr. Hill's essay lead away from the classics, at least as a medium of general education; and his generous admissions of their tried worth as instruments of training might, though unfairly, I think, be construed as the sort of admission a skillful debater, flushed with anticipated victory, will make of the strong points of his opponent's case; not to provoke a verdict for his adversary, but to gain credit for fairness on his own part.

A magazine article has some of the limitations of a sermon, due to the special advantage that it either never gets answered, or the answer must be addressed to different readers: even if it reaches the same public, no real debate results after long lapses of time. But an essay so stimulative and provocative as Professor Hill's calls for comment, and in the main rather for approval than for contradiction. There is instruction in it, too, for classicists, which a classicist may do well to urge on his fellows. There are observations to challenge, because they seem mistaken, and it may be well to point out that Mr. Hill's conclusion is a recommendation of change, to see what the result of change may be: it is not a consequence drawn from the observations of fact that went before it.

In the comment I am about to make, where considerations of space do not admit of full quotation, I shall do my best fairly to state the purport of Professor Hill's remarks, if for no other reason, for the sense of personal obligation I feel toward him for his pleasing and instructive "Introduction to Science" in the series of Temple Primers. But I make free, by virtue, perhaps, of the classicist's *hysteron proteron*, to rearrange the order of the original argument, even by transposing sentences from their own paragraphs, the which aim at no formal logical development.

I. *On the Part of Language in Education.*

Language ought to occupy a predominant position in school life.

II. *The Classics in Language Training.*

The mind-making property of the classics has been established beyond all doubt by innumerable experiments made upon juvenile minds of all types. It does not appear to me that, in the face of this mass of accumulated evidence, it can be regarded as a question open to dispute.

III. *The Classics vs. the Modern System.*

The essential difference between the classical and the modern system is the difference between training and teaching. A classical education is practically a training pure and simple: a modern education is a combination of training and teaching with mainly a teaching aim. . . . Like most other questions, there is no absolute distinction between the two systems—their difference is a matter of degree.

IV. *The Classics still Promise the best Training for the Professions.*

V. *The Classics not suited to Commercial Training.*

On this point I would make the obvious comment that the preparation for commerce, business and the trades, formerly entrusted to the apprentice system, has now been systematized through the "business college" and is being taken up in the *omnium gatherum* of the state university. So the "engineer" now gets his practical experience in the form of laboratory work at a technical school—but must often go over it again in the shops when he leaves the school. However much the classics might clarify the judgment and purge the taste of such students, it may well be that the classics have no closer claim upon them than when they were trained under the apprentice system. But sincere reflection would, I feel sure, persuade the most radical that classical study includes what is, for young people, the best training element in scientific study, viz., the accurate observation of phenomena, and the analysis and synthesis of the language crystal is a sort of crystallography of thought, with a subject matter intensely human. Students of my own who have gone over to the practical side have had no sort of doubt, that they carried with them minds trained for the apprehension and combination of phenomena.

VI. *Substitutes for the Classics.*

After all his generous recognition of the tried educative value of the classics Professor Hill concludes:

I have but one explanation. It was the rebound on to English which the classical drill produced. We were ceaselessly searching the pages of the dictionary. We were learning new words. We were studying English syntax.

These be fine words. We must admire them for their style, and we may fancy that this style is due to the classical study to which Professor Hill pleads guilty in his youth. Far from minimizing the force in these words we may as well admit that they contain truth, but is it the whole truth? Many persons have learned to write English without having studied any foreign language and without having studied Eng-

lish, even, in any way worthy the name. But school systems are not devised for such as these. Speaking generally, the English stylists have caught their trick from their classical studies, as Calverley's matchless versification has been attributed to his rigid training in classical verse-making. On the other hand, the lucidity of French prose, the stylistic excellence of which none but the French ever seem disposed to question, is supposed to be due to the direct study of their native tongue. A writer in *The Athenæum*,[1] put it this way:

> As our best English writers have learned how to write clear and accurate English from their long training in the subtleties of Greek and Latin grammar, so the French have attained their skill through the scientific teaching of their native tongue.

Certainly there can be small question that Quintilian's system of teaching, which laid stress on the mother tongue, failed not to teach the art of clear writing. But, given a method so thorough and detailed, one can not imagine his pupils to have saved any time as compared with Cicero, who attributed his attainment of style to his translations from and into Greek. Still, the Greeks, like the French, learned to write by studying their own language—which proves nothing against the value of discipline in a foreign language, for they also got their education without any substantial drill in mathematics.

Yet, after conceding much of what is claimed for the possible sufficiency of a modern language or the native tongue to meet the boy's need of language drill, it remains an open question whether, in giving up the classics, the loss in thoroughness and in interest might not exceed the supposed gain in time. There are two points we must not overlook, the value of the finger in the dictionary—twice emphasized by Professor Hill—and the great syntactical variety of the classics. These values, and particularly the first, can hardly be overestimated. In seeking to realize their peculiar part in classical study, we can do no better than begin with Professor Hill's own happy figure in which the Greek chorus is represented as a puzzle which the student has to rearrange into English. This accords with a favorite illustration of my own, which I point with Lewis Carroll's familiar line:

> He set them conundrums to guess.

In the puzzle lies a strong element of human interest. In my boyhood I used to notice how some puzzle of fox and goose and corn would set half a village to work to get them carried by twos across a stream—so stringless is puzzleland—without one animal or the other being left free to devour its natural food. A simple arithmetical catch would exercise the idlers at a cross-roads store for hours. Let us insist upon the human interest and the educational value of the puzzle and the riddle, and if my simple illustrations drawn from modern experience do not suffice to carry conviction, a pretty paper on "Riddles" in

[1] October 13, 1900, p. 473.

Mr. S. Baring-Gould's "Strange Survivals" will furnish better ones. Nor can we put his essay by without having been brought to think of how Carlyle was fain to ring the changes on the *cunning* of the *king*.

In the study of Greek and Latin we are confronted with language puzzles of the very best. Their solutions are in the reaching difficult, but when reached inevitable and convincing; and I do not hesitate to say that the means for reaching them are the best adapted to the end of any means now in existence. This means much. The natural boy likes a puzzle. He is rarely unwilling to work it out to a convincing solution. He does not shirk difficulties, but he wants to be sure of his conclusion. With a limited supply of books at his command, he can be more sure of his conclusions for the classics than for any other language puzzle whatever. To take the case of Latin, it is probable, in view of the narrow range of school authors, that a boy's Latin grammar more nearly accounts for his every possible difficulty, whether of form or construction, than does the grammar of any modern language. Such complete codification of usage as he commands in his Latin lexicon can never be anticipated, so far as I can see, for any modern language. Certainly no dictionary of equal convenience in the using can compare as an instrument of precision with the lexicon of Lewis and Short. Let me confess that the first fact that gave me the temper of the student was the discovery that I could find in Andrews's "Latin Dictionary," the inferior predecessor of the one mentioned, nearly every puzzling passage explained; and for some reason the condensed explanation of the lexicon by citation of parallel passages convinced and interested me more than any possible translation by an indulgent annotater. I suppose, to use one of Professor Hill's own figures, I more enjoyed my own piecing-up of the mosaic. A note seemed "telling" and I did not like to be told.

I keep within the bounds of truth and soberness, I think, speaking not as an enthusiast for the classics, when I assert that the modern-language puzzle can never be as difficult as the Greek, and more particularly the Latin puzzle. The reason for this, granting its truth, is not altogether apparent to me. The secret of the difficulty does not lie, I am persuaded, in the synthetic character of Latin. It does not rest primarily in the greater difficulty of Latin forms and syntax. Greek was always easier for me than Latin, and this experience is general, though not universal. I admit the greater difficulty of Greek forms. I agree that its vocabulary is more extensive, while English does not so easily help us to arrive at it. I believe the Greek syntax to be the more complex, and to involve rather more than fewer rules and principles. Yet with considerably more preparation in Latin, Demosthenes in the "De Corona" was easier to me than Cicero in the "Second Philippic." Easy and hard are relative terms, I know, but it might be possible to secure and tabulate a large number of opinions of students as to their

sense of the relative difficulty of languages. My personal experiences have been entirely convincing to me. While still a college student, but with five or six years of Latin behind me, I began one summer to study German privately, and after a careful reading, not conning, of the grammar, I set out to read a German novel. In a few weeks I could get on with it with some ease, and much more rapidly than I could then read Latin. In the next year's work at college Lessing's "Minna" and Schiller's "Tell," in long assignments, caused me much less labor than Latin authors did. Even now, after two decades of Latin teaching, with forms, syntax and vocabulary under good control, the Latin language puzzle at times presents difficulties. True, I require of myself greater accuracy with the Latin, but after a few weeks desultory dabbling with Spanish, I can read with enjoyment and a fair understanding a play of Echegaray or a novel of Galdós with far less concentration of attention than it requires to read a fresh bit of Ovid, or to reread for class preparation any but the most familiar satires of Horace.

My own experience aside, Professor Hill's surmise that the classics might be advantageously replaced in the educational scheme by a modern language or English seems to me not to weigh against the actual experience of a master in an English public school, Mr. John Charles Tarver, who thus expresses himself in his "Observations of a Foster Parent";

> The claims of history and geography are on the surface so obvious that I am tempted to a little piece of autobiography. Be it known, then, that my first ambition in teaching was to teach history. I had as little faith in Greek or Latin as the most ignorant of self-made men. I believed that great weight should be given to English literature and English composition; and as for language teaching, I saw no necessity for anything but French and German. Therefore when I speak of Latin as the best educational instrument, I speak with the authority of a person who has tried others. My opinion would be of no value at all had I never stirred out of the classical routine. Similarly, if I do not share the popular views about history and geography, it is after, not before experience (pp. 174–175). . . . The one great merit of Latin as a teaching instrument is its stupendous difficulty. Greek, in spite of its wealthy vocabulary and infinitely numerous inflections, is child's play to Latin (p. 79).

But why is Latin so much more difficult than a modern language? I find it hard to advance a reason. The differentiating factor lies not, I am convinced, in the forms. The German noun—unless its article were so helpful—is certainly as difficult in its forms as the Latin, and the Spanish verb seems to me even more difficult; but I make a fair headway in finding out the sense of Spanish or German, in spite of a very poor knowledge of the forms. This can not be done in Latin. Perhaps one reason lies implicit in the modernness of the modern languages. Their sphere of thought is modern and therefore mine. At least, I once heard this explanation advanced, with somewhat explicit reference to the ethical value of classical studies, by a great scholar and

a wise man, the Reverend Dr. John A. Broaddus, of Louisville. The only other reason I can divine lies in the greater variety of word order in Latin, the capacity of the phrase for variation, its unfixedness, as compared with the modern phrase. This is the only reason I can give myself for the close attention I must pay to get Horace's meaning in the "Satires," where language and syntax are thoroughly in possession, and the thought is plain and even *bourgeois*.

In the debate as to the respective educative value of the classics and the modern languages, the facts seem to justify the statement that the solution of the classic language puzzle requires greater effort, attention more concentrated and for a longer time. If this be true, and we abandon the old for the new, we must anticipate some necessary loss. It remains for the advocates of the change to demonstrate the contrary. In my opinion, the rebound from Spanish or German does not promise so active a motion. Possibly a language of a type very different from our own might produce a greater rebound. The Japanese who is learning English may well feel it a severer training than a German would. For myself, I can but think that the study which requires the greater concentration, like Latin, is more educative than the easier study like Spanish or French. I can but believe that the puzzle of a game like whist furnishes a higher recreation than the lesser puzzles of a game like euchre.

But Professor Hill thinks it likely that the due linguistic training of an Englishman might be had from the study of English, and above all of Shakespeare.[2] Supposing this to be true, who shall tell us that English would require, in the end, less time? Or that the study of English might not prove humanly less interesting? It is by no means clear that the paraphrase can replace the translation. Cicero, who tried the paraphrase of Latin as well as translation from the Greek, forsook the former as involving, if his stylistic model were well chosen, an almost sure replacement, in the paraphrase, of the better by the worse. In my mother's generation children were taught to parse and paraphrase Milton. I have heard them as adults describe the awful tediousness of it, in the tone of those who attribute their disregard for formal religion to a training in "The Shorter Catechism" and the strictness of the

[2] This point is well answered by the following citation from Dr. Arnold (Stanley's "Life," II., letter cxxxviii): "My delight in going over Homer and Virgil with the boys makes me think what a treat it must be to teach Shakespeare to a good class of young Greeks in regenerate Athens; to dwell upon him line by line and word by word, in the way that nothing but a translation lesson ever will enable one to do; and so to get all his pictures and thoughts leisurely into one's mind. . . . And how could this ever be done without having the process of construing, as the grosser medium through which alone all the beauty can be transmitted, because else we travel too fast, and more than half of it escapes us? Shakespeare, with English boys, would be but a poor substitute for Homer. . . ."

Scotch Sabbath. And what becomes of solving the language puzzle if we study English? Puzzles enough and to spare in Shakespeare, yes. But the puzzles appear in spots as compared with the somewhat continuous bepuzzlement of the classics, and their solution involves, in the main, only some bit of glossarial definition; it does not often demand a complete rearrangement of the thought.

Herein lies a cardinal distinction. As we read or study our own tongue we enjoy immediately something like a three-quarter apprehension of it, because it is English and because it is ours; and being what we are it is irksome to apply ourselves to getting a full comprehension. The truly educative thing in language study is, I take it, the effort to convert loose apprehension into thorough comprehension, and the greater the immediate apprehension, the less the effort and the less the stimulus to pass on to full comprehension. This point has been well made by Dr. Arnold:

> It has been my wish to avoid giving any pupils any Greek to do on a Sunday. . . . But I find it almost impossible to make them read a mere English book with sufficient attention to be able to answer questions out of it; or if they do cram themselves for the time, they are sure to forget it directly after.[8]

Plato-Socrates made this point long before in the Meno by asking whether one would earnestly seek and endeavor to learn what he thought he knew already, not knowing it—until at last, having fallen into embarrassment by being shown his ignorance, he longs to be taught.

In hearing or reading our own language we largely anticipate what is coming and this is what renders us liable to be bored. Thus the very ease of our apprehension makes us inattentive. With persons who speak like a book and with parsons at sermon, it is often enough to hear the beginning of a paragraph and wake up again at its end, quite sure we have absorbed the contents of a long stretch of discourse. Psychologically speaking, we stand in a very different relation to our own and to a foreign language. What we speak or write our motor currents, starting in the brain, we will say, transmit to our vocal organs or our pens, along nerve-fibers so habituated to such impressions that the consciousness does not become alive till we hear what we have said, or read what we have written. This is proved by the not uncommon experience that, while writing unconsciously, we spell correctly words that we misspell if we consciously attempt them: which shows how trite the native word and phrase become. On the other hand, when we read or listen, our sensory currents, transmitting to the brain what we see or hear, throb the more actively in proportion to the novelty, the strangeness of the object of consciousness. The only real stimulus is the novel stimulus. Our native speech, whether in motor or sensory transmission, provides less stimulus of novelty. It less quickens the attention. It becomes automatic. In our own language we read along cheerfully,

[8] Stanley's "Life of Dr. Arnold," letter No. 8, v. 1, p. 74.

with a very benumbed consciousness, not realizing how little we are understanding. A foreign language rouses our attention, and all the more in proportion to its strangeness. The modern tongues are modern and in part already ours; Greek and Latin, by their strangeness, more pervadingly quicken the attention.

And what becomes of the finger in the dictionary—a very different thing from a glance into a glossarial index—if our language study be English? Conceding that the same diligent attention might gain as good results from the English dictionary, how are we to drive students to give it such use? Driven they must be, for they think they know already. The strangeness of Greek and Latin furnishes the spur, does the driving for us.

VII. *Teaching Literature.*

Boys, whatever their career, must have some literary training, say the apologists for the present system of teaching classics. This is my contention also, but I advance it with still greater emphasis. The literary training obtained whilst learning Latin and Greek is indirect, accidental. It is too serious a part of education to be thus left to chance.

What a problem Professor Hill broaches here, literary training! President Woodrow Wilson, on the other hand, thinks that literature may be learned, but that it can not be taught: it certainly seems as if, in Teutonic lands, there is no developed method for teaching literature successfully. Nearly a score of years ago a despairing reviewer in *The Athenæum* wrote the striking phrase that courses in literature inevitably dwindled into "chatter about Shelly and the Harriet problem." One who like Professor Hill has admitted that "A man who has had a classical education has a craftsman's feeling for literature: he regards it as an artist regards a picture," has answered in advance his objection that "The literary training obtained whilst learning Latin and Greek is indirect, accidental." Granted, but what a splendid by-product—and I believe it to be only a by-product—"a craftsman's feeling for literature."

VIII. *On Practical Studies.*

There is the utmost haziness in the popular mind as to what studies are "practical." Nine out of ten would put mathematics at the head of the list. Only the simplest arithmetical processes are in general use, however. Only an infinitesimal proportion of those who have studied algebra, plane and analytic geometry, or calculus have ever made use of them. Adding machines and computation tables keep the bulk of the world's commerce straight. But nobody has studied Latin without being or feeling himself surer of his control of a third of the words of his daily speech. I have never thought the etymological a particularly strong argument for studying Latin, but it has been given me by students of my own whom I didn't think I had succeeded in getting to learn Latin. That the close study of an English dictionary might do

much the same thing for the boy, I freely admit; but the mass of mankind when they read are casual readers, and the casual reader does not use a dictionary.

IX. *How the Classics should be taught.*

Professor Hill's views on the teaching of the classics, and his strictures on certain proposed innovations, seem to me eminently sound. He has probably not heard of sundry American proposals to "enrich" the study of the classics, though the greatest enrichment would be to restore prose composition to its old place of importance. The indispensable value of the classics is the concentrated effort required in construing and writing them, the piecing-out of the English-classic language puzzle: this, and the finger in the dictionary, constitute the values that a modern language or the native speech will never—I do not say, can never, save in so far as what will not be can not be—replace. Whatever "enrichment" impairs these values is like a drug that would sap the heart while making the hair grow. It is abundantly right to say, with Professor Hill:

> For schoolboys Greek and Latin are exercises in grammatical expression, and nothing more. . . . Neither legend, history, philosophy, nor art has influenced the vast majority of the boys who have thriven on a grammar-school training. Stultify the grammar, distract attention from accidence, syntax, prosody, and the value of the gymnastic is reduced to nil.

X. *On the Relation of Language to Thought.*

> If we but knew the most rudimentary principles of the psychology of speech! What form of language is best suited for the expression of thought? What form of language is most favorable to thinking? . . . The test of the elevation of a language, from the evolutionary point of view, is its simplicity, freedom from ambiguity, correspondence in the order in which words are used with the sequence in which ideas successively occupy the focus of consciousness. "*Amabo*, love, future, I," is as swift an expression of thought as "I shall love"; although it does not place the constituents of the idea in the order in which they pass across the mirror of my mind; my personality, in the case of such a general proposition, takes the lead. "*Lucretiam amabo*," no doubt, gives the order aright. But neither conglomerate allows of the inversion "shall I love?" Picking up the schoolbook nearest to hand, I have essayed the "sors Virgiliana." This is the sentence which my finger touched: "Relinquit animus Sextium gravibus acceptis vulneribus."[4] It seems to me incredible that this sentence expresses the thought as it formed itself in Cæsar's mind: "Leaves it the soul Sextius by or to grave by or to received by or to wounds." Surely the idea of the personality of Sextius preceded the idea of some one fainting? What purpose is served by three times explaining that it was by or to (leaving it at the end an open question which) wounds?—"ibus," if it does not impress the mind of the reader as the really important constituent of the phrase, is unduly heavy for a mere inflexion. Cæsar did his best with the language which his unlettered ancestors had bequeathed to him: but he was to be pitied in that his thoughts when they went abroad must walk in irons.

We know little indeed of the psychology of language—which leaves us perhaps in little worse case than when we stand before the psychol-

[4] "De Bello Gallico," vi.

ogy of anything else. But our analysis of the main language problems must at last rest, I think, on the following observation: Language, the joint creation of the organs of speech and the hearing ear, became, by the invention of writing, a thing of written tracings addressed to the eye. Mere speech is not, in the nature of things, an object of study. The child learns it by ear, but his ear no more studies it than the eye studies optics to improve the sight. What we really want to know, and what we study in school, is written language, and we must always bear in mind the artificiality inherent in the strange medium. It can matter nothing to the infant who hears it whether he hear Greek or Zulu or English. He learns what he hears as unconsciously as a dog wags his tail. The conditions under which one tries to learn how to speak a foreign tongue are usually quite abnormal. That involves some conscious effort, doubtless, but whether the learner be a prince or the boots in a hotel, his most effective means of learning will be by ear, he must let himself be taught to hear. The rest is easy, provided he is young and has not been made self-conscious by a half-knowledge of grammar. Learning to speak a foreign language is, however, not a school problem, and I can foresee no conditions in the near future under which it is likely to become one. It would be well if those who prate of the practical value of the modern language would candidly add that for use as speech the French, German or Spanish that they recommend are, under the conditions that obtain, practically—if not potentially—as dead as Greek or Latin. It would be instructive, too, to get a statement from a thousand random men, who studied a modern language at school ten years ago, as to how many times it has been necessary, or would even have been convenient, to speak the language. Not but I would have persons learn to read or, if they could, to speak several modern languages, but if the Latin grounding has been thorough the acquisition of a reading knowledge of a modern language—and this is for people in general the practical thing—is a mere bagatelle. Again let me repeat it, for school purposes language study means the study of written languages, which is artificial and secondary. But though written language has developed habits and turns of its own; and writing has given to the registered phrase stability, variety, intricacy, whence the written word has acquired a special psychology of its own: yet it has never lost its inherited traits as speech.

This observation brings us to consider the order of words in language, a point on which Professor Hill betrays, *sit venia verbo,* some aplomb. He likes not an arrangement of thought in a different sequence from his own. Taking *"amabo"* for his instance, he rethinks it as "love, future, I," with some cavil at the relegation of his personality to the rear. In "*Lucretiam amabo*" the beloved, as he hints himself, might happen to prefer the Latin emphasis: if there were any emphasis. The truth is *amabo* is a crystal, a synthesis, and it appeals to the mind

as a whole. It is as much an entity as an icicle, the perception of which need not involve the thought of water, much less of hydrogen and oxygen. *Qua* analyst, I may divide *amabo* in one way for its syllables, and in another way for its root and stem, its tense and person signs. *Qua* hearer or reader, the unit is *amabo,* which I think I can mentally realize in rather less time than I realize "I shall love." My eye may see *ama-* sooner than it does *-bo,* but my consciousness appropriates them simultaneously. It is more probable that my eye sees *amabo* all at once, just as it is immediately aware of a flag, which it may then analyze as a tricolor, and last as three colored stripes. It requires no special act of enumeration to be conscious that a group is composed of five or six individuals, but the group is probably first to rouse my attention and my perception of it is a synthetic perception.

It was only the little lad learning to read from a hornbook at his grannam's knee that ever passed through Spencer's struggles with "the black horse," for it is an utter fallacy that "black horse" and "cheval noir" are, in speech, ever broken up into "black" [here ponder on "black"] and "horse"; "cheval" and "noir." And we shall not be entirely brutal if we disregard the distress of an American critic of style who thinks of "bay-horse" when he hears "cheval" and is pained to have his impression corrected by "noir": What an agony "the [bay] horse is black" must cause him. Nor need we make a prolix appeal to grammar or psychology to prove that "black horse" is, in the evolution of speech, shorthand for "the horse is black." This probably did not trouble our savage forefathers any more than it troubled the Romans, to whom either *niger equus* or *equus niger* alike meant "black horse" and "the horse is black."

Equally unhappy is Professor Hill's analysis of the Cæsar sentence cut at random after the manner of the *sortes Virgilianæ.* In its own context the sentence stands in the middle of a paragraph, and the reader coming upon it knows that Sextius has jumped from a sick-bed to rush with a few followers upon the attacking foe: paulisper una proelium sustinent . . . relinquit animus Sextium . . . gravibus acceptis vulneribus. To me also it seems incredible that the thought that formed itself in Cæsar's mind was anything like "Leaves it the soul Sextius by or to grave by or to received by or to wounds." The thought of Cæsar was in three phrases, "for-a-little together the struggle they endure . . . swoons Sextius . . . from dangerous received wounds." It can not be said too often that for the understanding the phrase is the unit. Ay, whether the medium of interpretation be the ear or the eye, the hearer or reader is simultaneously conscious of the whole phrase. When I say hearer or reader I mean, of course, Cæsar's predetermined hearer or reader, not the tiny learner spelling out *r-e-l,* etc., nor the older dullard who calls out words like sums standing in a column to be added. There is a trick of rhetoric, to be sure, in Cæsar's chiastic order, meant to

bring the verbs together in contrast, but it is easy to overstate the better adaptation of one word order than another for the understanding. The plain church-going American seems to find no difficulty with the line "Hangs my helpless soul on Thee" which, for rhythmic reasons, I always want to sing in the form "Helpless hangs my soul on Thee"; and "departed this life" is a formula very like *relinquit animus Sextium.* The desire to put the verb or other predicate forward has given rise to English turns like "There comes a stranger" or, in German, with wider reach, "Es klingelt die Glocke," "Es sperren die Riesen den einsamen Weg." Our American newspaper headlines are particularly given to this sort of striving for emphasis. I have seen examples of it occasionally in such carefully edited papers as *The Evening Post* or *The Courier Journal.* It runs riot in the text as well as the headlines of our local daily. Precious instances I recall are "Singing were"—A, B, C,—"Tyro is he"—who didn't enjoy so and so. And even in the high literary realm our now "Englished" minds still retain a great flexibility for word order, as for instance in parenthetic interruptions of the stream of thought, such as we find in the following: "No one else can feel the same interest in them [the boys], and no one else (I am not speaking of myself personally, but merely by virtue of my situation) can speak to them with so much influence."[5]

Shall Professor Hill assess Cæsar's feeling for the natural order of thought? Then he must take Echegaray, and many a Spanish author besides, to task, and ask them to make their stream of thought flow Englishly. He must ask the Germans to think more naturally. I can not think Cæsar was less natural than an Englishman and the natural order for Cæsar's thought was the order bequeathed to him by his untutored savage ancestors who spoke Latin; for the order of words in any given language is, I suppose, conformed to the order of thought—but hardly to the extent American Latinists were asserting a decade or more ago; as though every Latin sentence were arranged for emphasis in a diminuendo, beginning with a scream and ending in a whisper.

Professor Hill's rethinking of *gravibus acceptis vulneribus*—"by or to grave, by or to received, by or to wounds"—is scarcely less than grotesque, though I believe there is a recommendation abroad in the land to use as one reads Latin some sliding slotted card which shall reveal to the reader *gravibus* alone, leaving him to ponder the "from," "to," "by," relations before he passes on to *acceptis,* where, another wait, and so on to *vulneribus.* The propriety of this method may be tested by reading, with long, reflective pauses, as indicated, the following English sentence: "The chief made his son . . . a present . . . to the king." Here, stopping short, with false phrasing, ruins the sense. The truth is, the sentence is not "connected up" by consciousness till the last word, king, is reached. The mind, if not the ear, hears the whole

[5] Stanley's "Life of Dr. Arnold," v. 1, p. 152.

phrase at once, as the mind, not the eye, sees a complete circle of fire when the burning tip of a reed is turned rapidly about. False phrasing is like the false word division that misled Mr. Pickwick, the antiquarian, when confronted with the inscription

+
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It may seem *de trop* for an Englishman to indicate gender and number in his adjectives, but all the Romance peoples do it, and a German further indicates case. My experience as a teacher has shown me that the Latin ablative absolute, when you allow a slovenly translation, is a thing the dullest student fails not to recognize. Given the full phrase, and it is a blunder to give a student less, there is little more likelihood that even a dullard would, in our Cæsar sentence, for one moment think of the dative than the average reader would be likely to think of "bier" if he heard the sentence "Malt was used in making this beer." The fact is that what is theoretically equivocal in language is rarely so in experience. So true is this that only a few years ago French scholars went to the extreme of denying *in toto* the possibility of conscious effort to avoid verbal confusion: as though the whole stylistic juggle with synonyms—a phenomenon, to be sure, scarcely to be reckoned with in unlettered speech—did not look the other way.

On this point, I can contribute an interesting observation of a child's feeling for homonyms. My small niece, still under two, called her father, among other things, something like "baba," and we could not distinguish this name from her pronunciation of "barber," a word she probably had never heard till her little brother Jack went down the street one day to get his hair cut. Several of us, wishing to test whether she also confounded the two individuals, asked her questions like "Did baba cut brother Jack's hair?" But we never tripped her. The answer was always prompt as rhyme, "No, no, the baba." Were the two "baba's" she pronounced the same to her ear or did her acoustic image of the word "barber" contain the two very slightly trilled *r's* of our southern accent—though to the best of our observation they formed no part of her vocal reproduction of the image? Or was the differentiating factor in her mind the article "the"? The same child was not troubled by shifts in word order. One name she used for her father was "daddy-pops," and in trying to confuse her over the two "babas" I reversed it to "poppy-dads," which she instantly appropriated without a hint of confusion. A very simple shift of order will confuse an adult—perhaps the adult is more easily confused in this way—as I feel confused when I read from the Marseillaise hymn—

Contre nous de la tyrannie l'étendard sanglant est levé—

though it is so easy to rethink it as "Against us tyranny's standard of blood is raised."

No, the phrase is the unit. Of this I once had an almost convincing demonstration. A class was beginning Cicero's essay on old age and, as there were no books at hand, I began to read the first chapter aloud, slowly, and by phrases, with the result that I secured in this oral way a much better translation than the class brought up next day for their prepared lesson. If any one wants to convince himself of the superiority of Virgil in the narrative style to any other Latin poet, I know of no better test than reading him aloud by phrases: his brief phrases—not his words—move with a simplicity and naturalness not unlike the prose style of King James's version.

XI. *Analytic versus Synthetic Languages.*

We can not resist the impression that modern Greek and Italian, as they are but the ruins and vestiges of the languages in which Demosthenes and Cicero spoke, afford by comparison but miserable accommodation for thought. From our extremely small experience of the speech of the world we judge that, in the case of the few languages which we know, evolution has proceeded backwards: the better organized, and therefore, from the evolutionary standpoint, the higher language has given place to the lower. . . . Greek and Latin were not made by cultured Greeks and Romans. The language took form in the converse of their illiterate ancestors. Literature, upon which the beginnings of culture rest, closes language building in the larger sense. Zulu is a more highly flexional language than Greek. . . . The language of the Zulus is not great because it is complex in form. Every language becomes great when greatly used—Greek from Demosthenes's mouth; English from Milton's pen. . . . The only evolutionary tendency in language which we can recognize is this tendency towards analysis, toward dismemberment. So great an authority as Sir Charles Eliot, vice-chancellor of Sheffield University, who perhaps knows a greater variety of languages than any other man, from Portuguese to Russian, from Turkish to Japanese, languages of central Africa and of the Polynesian Islands, tells me that he considers that this progress favors thought. Gender, number, case hamper language, restrict its flexibility, impede thought. A monosyllabic root-language, such as Chinese or Burmese, is a swifter and more precise solvent of thought than are the highly inflected Bantu tongues. If this be true—and it does not seem to me open to doubt—it is easier to think in English than in Latin.

I have not the least doubt that it is easier for Sir Charles Eliot, Professor Hill or me to think in English than in Latin. The great educative value I assign to the study of Latin lies precisely therein. The rethinking of Latin into English can not fail to be tremendously more difficult than the rethinking of any modern cultural tongue into English. But Professor Hill is dealing with postulates, not demonstrations. Who shall show us that Cicero's Verrines cost more effort in the thinking and phrasing or appealed less simply and directly to his audience than Burke's "Impeachment of Warren Hastings"?

The scientist is very apt to carry a chip on his shoulder when the word evolution is mentioned. He seems to feel it treason to science if evolution is not regarded as a universal principle, as absolute in its operation as the law of gravitation. Because he believes in progressive development and the survival of the fittest, he mechanically postulates that whatever is is better than all that has passed away. Applied to the institutions of men this principle is abundantly untrue. If it comforts one to classify the differentiation of organ and function from diatom up to man, and the general simplification of structure observable in the historical development of languages as they grow older, under the one label, evolution, he is welcome to do so, but he must meet the difficulties and see the differences. If it is a simplification that the Romance languages have replaced Latin synthetic cases by prepositional phrases, why, after having acquired an analytical future, did they convert it into a synthetic: why has Spanish developed *hablaréis* "you will speak" from *hablar habéis* "you have to speak"? Who will assure us that the Latin case-endings did not similarly arise from some sort of attachments of prepositions to their nouns? Why is *-(i)bus* too heavy for a mere termination? [What is there about *-bus* that catches the ear of persons who hear Latin? Shakespeare's Costard hits off some of the catching elements of spoken Latin in his honorificabilitudinitatibus, and I can testify to the prominence of -bus in the gibing attempts at Latin word-formation I have heard from mockers.] Who can seriously maintain that *-"bus"* attached to a Latin stem is inherently any more ambiguous than "by" or "with" prefixed to an English noun? What *-bus* was to start with, philologists surmise, they do not know. But they do know that Spanish *migo* is Lat. *mecum* synthetized and reanalyzed again in *con migo* which is *cum mecum.* The psychology of the doubling they understand, but they don't drop the *-go* from *migo;* and they accept the fact for the fact, content with the unlettered ancestry of Spanish or Latin or English. Who then, I repeat, shall assure us that the Latin case endings did not originate similarly from some prepositional affix? It is absolutely certain that Latin *amabat* "he was loving" has been synthetized from an independent word meaning, either "loving" (ptc.) or "for-loving" (infin.) plus *-bat* "was."

The truth is that all along the line language submits itself to synthesis. We have an interesting exhibition of this in the colloquial American "kinder" and "sorter," for which our language has, I conceive, a real need as a verb modifier. At least I can not express in formal language the very pretty group of associations suggested to my mind by the phrase "He sorter sidled up to her and whispered." Analytic and synthetic are but relative terms and sometimes the synthetic form of expression is the simpler. To me at least, in the French line quoted above, *de la Tyrannie,* though analytic, presents to me in a blur, as

through a glass darkly, what I see crystal clear in the synthetic possessive *Tyranny's* by which I have rendered it.

As I have already said in another connection, German in its noun and Spanish in its verb are at least as synthetic as Latin, spite of an evolution longer by two thousand years. That these languages with their rich flexional systems and their concords for gender, number and case are instruments more difficult in the use or less apt in the expression of the thought of Germans and Spaniards than English is for us is sheer assumption; and it were a peculiarly chauvinistic obsession to call German or Spanish languages of a lower type than English. In the estimation of the difficulty that attaches to learning and using a national tongue, no foreigner's opinion can possibly assess the difficulty for the native. As regards the adequacy of a language to express the thoughts of its native users, it may be said that no type of language has ever been found inadequate. Homer's Nestor of the honied tongue with many flexions; Demosthenes with fewer; Cicero with his adjective cases and genders and his verb moods; Burke in a nearly flexionless English: who shall say that one of these commanded a language of less flexibility, a language less apt for the expression of thought, than another? Did Greek flexions hamper Demosthenes, restrict his thought? The appeal of Demosthenes to-day is in part due to Demosthenes, but in part to what used to be somewhat sentimentally called the genius of the Greek language. I can conceive of a Zulu approximating Demosthenes before a Zulu audience, but not of a Zulu Demosthenes whose appeal could reach me, unless he had been steeped in a Zulu literature accessible also to me.

Language is the expression of thought, but it is more, it is the prompter of thought. A word is not only what it means, it is all that it suggests by association. Rhyme, often decried as a meretricious embellishment, has helped modern poets to many a richer thought. Metaphor so completely triumphs over the worn and literal expression that it may be said to do our thinking for us. But metaphor continually wanes in the word till all becomes literal again. The metaphors of a foreign language, of Greek and Latin, where they differ from our own, freshen thought. Other freshening of metaphor is—slang. Demosthenes, the heir of all his ages, put his thoughts in Greek, but Greek no less put her thoughts in him. Man is the weaver but words are the yarn, and the yarn is delivered to him spun and dyed. Its strands are thought, its color emotion. The weaver has, in fact, little to do. He can at best but a little vary the conventional pattern, handed down to him by his unlettered ancestors. Or again, changing the figure, we may say that language carries its own organic ferments. These ferments set the poet's eye in a fine frenzy rolling. These ferments supply a vapor aglow with light that never was on land or sea. Some flash of a word —and we see the stars; some sputtering word—and our noses flinch.

AGRICULTURE IN THE HIGH SCHOOL

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THE proposition to put agricultural courses into the existing high schools may seem, at first thought, to be merely one of adding another subject to the curriculum. But experience shows that a curriculum may not be dealt with arbitrarily. To successfully inaugurate this subject it is necessary that study be made of its purposes and, more especially, of the adjustment of this to other high-school subjects.[1]

The subjects of the present curriculum most concerned in this adjustment are the sciences. These, "the most precious achievement of the race," are themselves comparatively new to the curriculum and the promise with which their introduction into the school was made has fallen far short of fulfillment, so that their status is at present far from a final adjustment.[2] And their close relation to the new subject, agriculture, makes the problem of the adjustment of all a single problem.

[1] "No study is worthy of a place in our program which has not commanded the full devotion of some master mind. All students must be introduced to the same civilization, and since all are human their several ways of approaching it will not be fundamentally different."—Brown, "The Making of Our Middle Schools," p. 440.

[2] "Science is the most precious achievement of the race thus far. It has made nature speak to man with the voice of God, has given man prevision so that he knows what to expect in the world, has eliminated shock, and above all, has made the world a universe coherent and consistent throughout."—Hall, "Adolescence," Vol. II., p. 544.

"This recognition of science as pure knowledge, and of the scientific method as the universal method of inquiry, is the great addition made by the nineteenth century to the idea of culture. I need not say that within that century what we call science, pure and applied, has transformed the world as the scene of the human drama; and that it is this transformation that has compelled the recognition of natural science as a fundamental necessity in liberal education."—Eliot, "Education for Efficiency," p. 37.

"I can not help feeling . . . that we have not yet succeeded in so organizing the sciences as instruments of general education as to fulfill the high expectations which some of us formed for them nearly a quarter of a century ago. There can be little doubt that the sciences of nature and of man, properly organized and presented as educational instruments, are destined to be classified as true humanities."—Butler, Address of Welcome, A. A. A. S., 1906.

"It seems to be a fact that the sciences, although dealing in knowledge of matters of the greatest immediate interest, and although concerned with the most elemental of all trainings . . . are still of mediocre efficiency as factors in general education."—Ganong, "Botanical Education in America," A. A. A. S., 1909.

The strength of the agriculturists' argument for the inauguration of courses in the schools has usually pertained to the immense economic significance. But the successful teaching of agriculture in the school along with the traditional courses depends, like all the rest, upon its being regarded and developed as a humanistic subject as well. It will have to "make good" pedagogically if it is to have a permanent place.[3] But it is also likely that pedagogy will have to recognize some new educational values before the subject can be considered in good standing by schoolmen. When educational ideals include the highest ideals of social efficiency the economic will, of course, be included. But until there is a recognition of something more than economic ideals there may be danger of the industrial reform getting in the way of educational progress, to the ultimate detriment of both.

A usable pedagogy is necessary to the solution of this problem. If pedagogy does not afford the principles and terms with which to treat the subject it is a sign that we need a new pedagogy.[4] Those who seek unity in education should insist that the "science of education" proceed to attack the problem with such means as it possesses. The result may be worth as much to education as to agriculture.

Without guiding educational principles the common mistake regarding this subject is to suppose that agricultural materials have inherent qualities which determine how they should be marshaled in the course. The result is the confusing variety of mechanically graded topics which secondary courses in agriculture present. As a matter of fact any purely agricultural theme will have phases which might be appropriate for any grade. The thesis here maintained is that the child's mind and body, rather than the materials, should be the controlling factors that determine all courses of study and that in the high school these must first, in this case, determine the organization of the sciences. For the

[3] "In the study of the concrete problems of education, we need a guiding principle; we need a formula that will cover every case that is presented; we need to know what education means in its simplest terms. Having such a principle we shall have a basis for interpretation—a criterion, perhaps, for approval or condemnation. Lacking such a principle, our results will be the merest empiricism, valuable it may be as separate facts, but totally inadequate to the needs of constructive effort."—Bagley, "The Educative Process," p. 3.

"Experience in teaching, covering several years in graded-school work, in an academy, and in a normal school, leads to the conviction that no subject requires more sound knowledge of the principles of pedagogy than does the subject of agriculture."—Abbey, "Normal School Instruction in Agriculture," p. 9.

[4] "New and fundamental concepts regarding educational principles are now needed which square with centralized and systematized industry."—Carlton, "Education and Industrial Evolution," p. 13.

"If pedagogy or education is to be permanently ranked among the sciences, it must find data in addition to that furnished by cultural imperatives and psychological investigations."—Carlton, "Education and Industrial Evolution," p. 18.

only features of agriculture that have pedagogic cohesion are the sciences involved.

Presented as they have been without any experience in their utilization having been afforded, high school sciences have not kept pace with educational needs. The fault seems to be that the student has been held too rigidly to the accuracy of an accumulated knowledge with too little experience with the method of its acquisition.[5] Pure science can be but imperfectly appreciated by the adolescent who still retains his dominant childish interest in the use, rather than the organization and structure, of things.[6] And if science *could* be taught as pure science its destructive tendency, striking as it does at the root of authority, is of questionable propriety where it does not at the same time furnish a philosophy of life. It is especially necessary under a rational government, such as ours, that it be made humanistic.[7] And humanistic science is applied science.

The purposes of high school agriculture, therefore, await the reform of the high school sciences; and a reform in the direction of applied science is evident to many science teachers who have no special interest

[5] "Science teaching has suffered because science has been so frequently presented just as so much ready-made knowledge, so much subject-matter of fact and law, rather than the effective method of inquiry into any subject-matter. . . .

"Only by taking a hand in the making of knowledge, by transferring guess and opinion into belief authorized by inquiry, does one ever get a knowledge of the method of knowing. Because participation in the making of knowledge has been scant, because reliance upon the efficacy of acquaintance with certain kinds of facts has been current, science has not accomplished in education what was predicted for it."—Dewey, "Science as Subject-matter and as Method," A. A. A. S., 1909.

[6] "What the pupil is unable to use at any time can not be taught him most economically and efficiently at that time."—O'Shea, "Dynamic Factors in Education," p. 41.

"Then (in adolescence) . . . come the need of utilities, applications to machinery, hygiene, commerce, processes of manufacture, the bread-winning worth of nature knowledge, how its forces are harnessed to serve man and to produce values. Contrary to common educational theory and practise, the practical, technological side of science should precede its purer forms."—Hall, "Adolescence," Vol. II., p. 153.

[7] "An interpretation of humanism with science, and of science with humanism, is the condition of the highest culture."—Symonds, "Culture."

"As our schools grow more national they should also grow more humanistic. The older humanism was devotion to . . . an abstract ideal. The newer humanism of the schools can not well dispense with the best that the older humanism had to offer. But it will cease to be abstract. . . . The best that the school can do to guard them (youth) against self-centered commercialism, is to awaken their enthusiasm for some ideal good, which has power of appeal to the imagination. . . . We may look to see . . . a new humanism, leaning more and more on science, mindful of the past, patriotic in the present, and looking hopefully forward to the larger human interests."—Brown, "The Making of Our Middle Schools," p. 463.

in agriculture. The biologists, especially, are gravitating toward the use of the familiar things with which agriculture must deal.[8] If the agriculturists do not take advantage of this it will be their own fault. For if the scientists are to assume that part of the burden for the sake of the sciences, such "loss of jurisdiction" over their subject should not be taken amiss by the agriculturists, who may rest assured that the others have no means of cheating so as to achieve their "disciplinary" results wthout thereby doing that which is best for agriculture. Only in making the two phases of work complementary is agriculture securing a permanent place in the course. It may be that keeping the two interests uncorrelated will not only result in the continued decadence of high school science, but will also keep the subject of agriculture pedagogically outside the course of study, however much pains may be used to print it in.[9]

Agriculture in the high school will bear one of three relations to the fundamental sciences, namely, it will be taught before the related sciences are taught, or while they are being taught, or after they have been taught.

The success of agriculture in the high school depends upon its being made of such dignity as to challenge the powers of the better students.[10] And the better students will not be attracted to a subject that is long kept in its elementary stages.[11] There is more to lose than to gain in

[8] "I often wish that the phrase 'applied science' had never been invented. For it suggests that there is a sort of scientific knowledge, of direct practical use, which can be studied apart from another sort of scientific knowledge, which is of no practical utility, and which is termed 'pure science.' But there is no more complete fallacy than this. What people call applied science is nothing but the application of pure science to particular classes of problems. It consists of deductions from those whose general principles, established by reason and observation, constitute pure science. No man can safely make these deductions until he has a firm grasp of the principles; and he can obtain that grasp only by personal experience of the operations of observations and of reasoning on which they are founded."—Huxley, "Science and Culture," Chap. IV.

[9] "In every case correlation has been successful, when the instructor was sufficiently versed in his own subject and the kindred subjects to know when and how to bring the two together to the best advantage."—Abbey, "Normal School Instruction in Agriculture," p. 29.

"Relate the school to life, and all studies are of necessity correlated."—Dewey, "The School and Society," p. 107.

[10] "The highest type of spontaneous, whole-souled activity can not be developed about trifling or worthless things."—Hodge, "Nature Study and Life," p. 23.

[11] "If a child at any particular epoch in his development is compelled to repeat any fixed form of action belonging to a lower stage of development, the tendency will be for him to stop at that point, and it will be difficult, if not impossible, to get him up on to a higher plane. . . . Thoroughness in the pursuit of any study in the elementary school may result in cessation instead of promotion of mental growth."—Harris, "Educational Creeds of the Nineteenth Century," pp. 39–40.

attempting to popularize the subject by writing all of the science out of it. If it is not based upon the fundamental sciences it is not secondary but elementary, and, as such ignores the genetic stages of development usually represented by the high school adolescent.[12] Therefore, if agriculture is to be made a secondary school subject it must be put on a secondary plane—that is, it must be made scientific by the utilization of the fundamental sciences.[13] It should not be divorced from the high school sciences in order to precede them.

The deferring of the agricultural work in the high school until after the underlying sciences have been mastered will be at the very imminent risk of starving the peculiar vocational interest upon which its success depends. Investigations as well as experience show that the interest in vocation is born in adolescence and that the manual vocations normally precede the others.[14] It is a maxim of education that to develop a useful instinct it should be exercised and directed during its nascent period.[15] However judicious and far-sighted the plans of the teacher may be regarding the student's high school course, neither the student nor his parents may be safely left indefinitely in the dark regarding them. The average student in the high school should see a generous amount of purpose in all of his work and have the benefit of such experiences as are to be gained only by applying it to its purpose, even though it mean, from the viewpoint of the teacher, a compromise of his science.

Prescribing high school science work to precede the agriculture

[12] "When he (the pupil) has completed his eighth year, he should have a well-developed sympathy with agricultural affairs and he should have a broad general view of them. Entering the high school he will then be able to take up some of the subjects in their distinctly scientific phases."—N. E. A. Committee on Industrial Education in Rural Schools, pp. 44–45.

[13] "It is the business of secondary education to raise all subjects which it touches to the plane of science, by bringing all into the point of view of organizing principles."—Brown, "The Making of Our Middle Schools," p. 4.

[14] "In almost all great men the leading idea of life is caught early."—Eliot, "Education for Efficiency," p. 28.

"Until the instincts of construction and production are systematically laid hold of in the years of childhood and youth, until they are trained in social directions, enriched by historical interpretation, controlled and illuminated by scientific methods, we certainly are in no position to locate the source of our economic evils, much less to deal with them effectively."—Dewey, "The School and Society," p. 39.

[15] "If a nerve center is not exercised properly during its nascent period, it will be arrested in its development, for it loses its plasticity when the wave of ripening moves past it to other centers. . . . The absence of appropriate stimulus during the growing period is for the most part irremediable; and this results, as I have already intimated, not only in the arrest of this particular function, but it influences other functions by interfering with the readiness of association between centers that can become connected only through the undeveloped one. . . ."—O'Shea, "Dynamic Factors in Education," p. 151.

means either the perpetuation of a form of science instruction that has proved a failure in the high school or it means a reformed science, such as many teachers are now advocating, that introduces industrial applications. If the latter kind is contemplated it should be unnecessary to provide for it again in the agricultural course, for to admit that it can not be so utilized is to take all of the meaning out of the reform. If the former kind is contemplated, such students as can not appreciate "pure science" however elementary, may not be expected, after organizing a science in its more perfect form, to profit by any attempt later to open the subject and reorganize it in a less perfect form for agricultural or other utilitarian purposes, as an addendum, loosely attached and unessential, which must deal with drosser materials. The period for such organization is past for the student who can appreciate the science in its more perfect form, while those who might have profited by the compromised science will have been long since eliminated. Thus would both subjects suffer from the divorcement and postponement of agricultural instruction. The conclusion is that agriculture is not supplementary, but complementary, to the fundamental sciences in the high school.

In the days of pre-evolutionary thought, when learning was all a matter of authority, it was quite natural to think of form as dictating function, and formal knowledge monopolized the schools. The acceptance of the doctrine of evolution was a recognition of the fact that function dictates form.[16] According to the present conception the best teacher is that one who does not have the two very far separated in time.[17] In order that the high school science be properly taught it is necessary that the teacher have a ready knowledge of its function and that it be carried to its application while the subject is first being presented and is yet in the formative stage in the student's mind.[18]

The technique and terminology of pure science are the only adequate technique and terminology of applied science. The only difficulties which the student of agriculture meets are scientific difficulties.[19] It would be strange indeed if such difficulties might be better dealt

[16] "As structure follows function, experience in function must have been first in race history."—Baldwin, "Mental Development, Methods and Processes," p. 64.

[17] "As far as possible the study of form and function should go together."—Bailey, "The Nature-study Idea," p. 49.

[18] "The application in some form should always follow the generalization. The pupil should learn from the start that knowledge as it exists in the form of laws, principles, rules or definitions is utterly valueless, unless, directly or indirectly, it can be carried over into the field of practise."—Bagley, "The Educative Process," p. 303.

[19] "Any attempt to 'cut out' the 'impractical' parts invariably results in the inefficient functioning of the remainder. Short courses that aim to give only the essentials, fifth-rate colleges and normal schools that educate you while you wait, are sufficiently damned by their own products."—Bagley, "The Educative Process," p. 233.

with dissociated from the sciences to which they pertain.[20] So far as the two are related, the purposes of science can not be antagonistic to those of agriculture and it is better for the accomplishment of the reform toward vocational education to let the sciences bear their share of the burden of time and responsibility and have the same "charged to their account" while profiting as they will by the inclusion of the latter.

Should agricultural materials and principles be utilized for the purpose of teaching the sciences, and the student progressively pursue his science beyond the ability of agriculture to give any direct benefit, the operation of constantly rejecting the unessential and reconstructing with the (apparently) essential for the purpose of perfecting organization is a mental operation quite familiar to educators and is observed in daily practise by good teachers in all subjects. It is a characteristic merit of the "scientific method" and the "spiral plan," and is generally recognized as the natural order of mental growth. Thus most of the knowledge acquired in school is but transient in its value—a scaffolding for the erection of a more perfect structure.[21] It is not the agricultural work considered as knowledge so much as the right kind of training in science which its inclusion alone insures that makes it the best means of preparation in science for any collegiate course or for any general educational purpose.

But the fundamental sciences can not be depended upon to give a complete treatment of the subject of agriculture as it should be treated in the high school.[22] Where manual skills in technical processes are

[20] "In order to develop a subject well, . . . it is necessary to establish and maintain a favorable atmosphere for that particular field of mental activity, and this atmosphere is at its best only in the presence of students interested mainly in that subject; that is to say, there is no more favorable place in which the farmer may study chemistry than in company with others, not merely of his own kind, but of those who believe that chemistry is the greatest thing on earth."—Davenport, "Education for Efficiency," p. 103.

"Learning a business really implies learning the science involved in it. . . . A grounding in science is of great importance, both because it prepares for this and because rational knowledge has an immense superiority over empirical knowledge."—Spencer, "Education," Chap. I.

[21] "Coarse, crude, rapid work must come before refined, delicate, painstaking work. . . . On the other hand, if we permit the child to take his own gait he will be likely to stop upon some low stage of development. . . . To keep him at coarse, crude work continually would be a serious mistake. We must set the pace for him."—O'Shea, "Dynamic Factors in Education," p. 168.

"The most he knows at forty will be learned out of school, and . . . the business of the school is to give him a good start."—Davenport, "Education for Efficiency," p. 76.

"All our industries would cease were it not for that information which men begin to acquire as best they may after their education is said to be finished."—Spencer, "Education," Chap. I.

[22] When I speak of teaching agriculture in our high schools, I mean agriculture. I do not mean nature study, nor do I mean that some sort of pedagogical

to be taught, or the quality of grosser products studied, independent class work must be provided throughout the course. Then there are certain scientific phases which must be pursued in class further than may be thought profitable to the science student, though the cases are not nearly so numerous as is generally supposed.[23] Such training must be provided largely by collateral courses and from students' projects carried on at their homes. And it is necessary that agricultural students who purpose to apply their knowledge to that vocation, be segregated late in the course for the treatment of the subject as whole, where its ideals may be developed and its various phases synthesized into an independent "science of agriculture."

Could it be known at what stage a young person's schooling is to cease, his best interests seem to dictate a previous substitution of immediately usable knowledge for much of that of merely "disciplinary" or "preparatory" value.[24] The practical difficulty of accomplishing such

kink should be given to chemistry or botany or even geography and arithmetic. Let these arts and sciences be taught from their own standpoint, with as direct application to as many affairs of real life as possible; but let chemistry continue to be chemistry. . . . Every high school that has a natural agricultural constituency of any considerable importance should put in a department of agriculture on the same basis as its department of chemistry.''—Davenport, ''Education for Efficiency,'' p. 126.

''A thorough grounding in the natural sciences is essential to thorough agricultural courses, but so long as the instruction is confined to the departments of pure science it has had, and will have, very little significance or importance to agriculture. . . .

''If the divisions of science were strictly adhered to we should have no such thing as agricultural science. . . . The present-day plan for the classification of agricultural knowledge and its formulation into courses of instruction . . . is based on the application in the natural divisions of agriculture, rather than on its scientific origin. . . . A proposal to return to the former basis of the primary sciences would find scant indorsement among men who have studied the pedagogics of agriculture.''—Editorial in *Experiment Station Record*, January, 1908, p. 402.

[23] ''The sharp distinction between preparation for college and preparation for life is fading out. . . . So far as general culture is concerned, preparation for a higher school, rightfully conceived, coincides with preparation for life.'' —Brown, ''The Making of Our Middle Schools,'' p. 438.

[24] ''Vocational training is to be postponed as long as possible. It is to rest upon the most extended general schooling which the individual can get.''— Brown, ''The Making of Our Middle Schools,'' p. 459.

''The human plant circumnutates in a wider and wider circle, and the endeavor should be to prevent it from prematurely finding a support, to prolong the period of variation to which this stage of life is sacred, and to prevent natural selection from confirming too soon the slight advantage which any quality may temporarily have in this struggle for existence among many faculties and tendencies within us. The educational ideal is now to develop capacities in as many directions as possible.''—Hall, ''Adolescence,'' Vol. II., p. 88.

''Vocational training ought not to be included in the six years that are sufficient for the elementary school course. . . .The grave error of the past has been to frame a school course on the hypothesis that every pupil was to go for-

purpose in our mixed schools is not only the inability of foreseeing and planning for individual needs, but also in the inadequacy of funds and teachers to satisfy such needs. On the assumption that a high school course and no more is to be made available to every youth of the land, such needs, except for delinquents and defectives, may best be provided in the latter part of the high school course.

This would mean the utilization of agriculture so far as applicable in the teaching of all subjects and all kinds of students, with a gradual increase of the purely vocational phases for such students as have elected agriculture as a vocation. Thus would the correlated sciences be better treated for their own purposes without greatly disturbing the present system of accrediting schools and subjects, leaving the accrediting of the strictly vocational subjects of the same school to be dealt with separately. And it is necessary, if we would secure the right kind of science teaching as well as vocational courses with thorough foundations, to have them taught in the same school, else may the one be divorced from its source of strength and the other become no more than elementary and baldly utilitarian.

The "preparatory" value of the vocational side of the agricultural course may be considered apart from the reform of the sciences. It is this consideration that makes necessary the admission of educational values, until recently not recognized as such by schoolmen. First might be mentioned the significance to the young learner of testing by a muscular manipulation the objects of his environment. Such objects are of value as educational materials to the degree to which they call for necessary muscular adjustments similar to those which the race from the earliest times has experienced. Every sensation or thought, the psychologists affirm, naturally stimulates a motor adjustment which reinforces the original sensory or central impulse which originated the motion. And this "back stroke" from the muscle furnishing the unifying "*kinesthetic factor*" is a thing to be encouraged and not repressed, as has too often been done in school work.[25] In the earliest

ward in the most deliberate and amplest fashion to the study of the products of the intellectual life, regardless of the basis of his own economic support."—Butler, "Training for Vocation and for Avocation," *Educational Review*, December, 1908, pp. 472–474.

[25] "We have lately become convinced that accurate work with carpenter's tools, or lathe, or hammer and anvil, or violin, or piano, or pencil, or crayon, or camel's hair brush, trains the same nerves and ganglia with which we do what is ordinarily called thinking."—Eliot, "Education for Efficiency," p. 38.

"Every mental state is a fusion of sensory and motor elements, and any influence that strengthens the one tends to strengthen the other also."—Baldwin, "Mental Development; Methods and Processes," p. 440.

"No serious thought is possible without some voluntary effort, and no emotion ever arises without inducing some form of action."—Judd, "Psychology," p. 66.

years of childhood this need is most urgent, but may be regarded as always necessary in the nascent stages of any instinct. The instincts that pertain to vocation are born in adolescence, and agriculture, whether as a means or as an end, furnishes ideal materials and situations with which to work.

Akin to this kinesthetic factor is the value to the young of discovering and exercising his power of *control* over natural forces. Hitherto much of the work of the school has trained a passive contemplation of the things which concern an education. Here is a subject that incites to action and rewards in a material way the efforts of the youth to take a hand in directing the outcome. He thus gains a much-needed training in his power to get results and produce something of value to society.[26]

There is an educational factor of great and peculiar value known to our pioneer grandparents as *hardship,* but which we prefer to think sufficiently covered by the term *responsibility.* The educational value of responsibility has long been known, but to create situations for its exercise is an unheard of thing in education.[27] Perhaps it will never be possible to prescribe experiences that can be as valuable as the real crises of life, nor to be able to prejudge the ability of youth to arise to the occasion when the crisis comes. But if the attempt is to be made by the school to develop a sense of responsibility for the successful issue of an undertaking—and who shall say what the school may not undertake for the good of the young—certainly no one who has ever made the investment which even a small agricultural undertaking entails, and which can neither be delegated nor hastened, can deny the possibilities of this subject.

"James, Hall, Dewey, Mosso, Wundt, Baldwin and others are preaching a new gospel. They are saying that the child's thought is never dissociated from his muscles; that every idea has a motor aspect; that mind is in one sense a middle term between the senses and the muscles; that it functions for the purpose of guiding conduct; that an idea is not complete until it is realized in action. . . .

"Viewed from the psychological standpoint it appears that muscular experiences are essential to the gaining of clear, definite, effective ideas in the world." —O'Shea, "Dynamic Factors in Education," pp. 27–29.

[26] "Properly thou hast no other knowledge but what thou hast got by working: the rest is all a hypothesis of knowledge; a thing to be argued in schools, a thing floating in the clouds, in endless logical vortices, till we try and fix it." —Carlyle, "Past and Present; The Blessedness of Work."

"The pupil must learn what nature is by trying what he can do with it; thus he measures it in terms of his own strength and skill, and discovers how it can be manipulated; and it is this experience that holds vital knowledge, and that enlists genuine interest."—O'Shea, "Dynamic Factors in Education," p. 52.

[27] "One of the last sentiments to be developed in human nature is the sense of responsibility . . . in the development of which our carefully nurtured and protected youth of student age . . . have had little training."—Hall, "Adolescence," Vol. II., p. 415.

Lastly, there are the unequaled opportunities of a *sociological* or *missionary* nature which come oftenest to one possessing practical knowledge and which if taken advantage of make him truly altruistic. Hitherto the real if not the admitted purpose of education has been the good of the educated, however much society, as a whole, may have profited from its educated members. But it is coming more and more to be recognized that no feature of an educational system, supported at public expense and whose single aim is citizenship, can be defended that does not contribute directly to social efficiency.[28] Social efficiency includes all that may be appropriate to the most utilitarian phases of industrial education, but it includes a good deal more. Racial betterment must be the compelling motive. On the final test of social efficiency "he that is greatest among you shall be your servant."[29]

The evaluation of these hitherto unassumed school functions is, to him who insists that everything done in the school be assigned its proper "preparatory" value in credits of admission to higher institutions, the difficult end of the problem of the adjustment of agriculture to the course of study. The purpose of the high school is to undertake them and do them to the best of its ability, leaving it to the college and university to worry over their pedagogical classification and estimation.[30]

[28] "Effort for the production of property is ethical, and the moment the child engages in it he places himself on the side of law and order in the community."—Hodge, "Nature Study and Life," p. 30.

[29] "No matter how full a reservoir of maxims one may possess, and no matter how good one's sentiments may be, if one have not taken advantage of every concrete opportunity to act, one's character may remain entirely unaffected for the better. . . . A character is a completely fashioned will, and a will . . . is an aggregate of tendencies to act in a firm and prompt and definite way upon all the principal emergencies of life. . . . Every time a resolve or a fine glow of feeling evaporates without bearing practical fruit is worse than a chance lost; it works so as positively to hinder future resolutions and emotions from taking the normal path of discharge. There is no more contemptible type of human character than that of the nerveless sentimentalist and dreamer, who spends his life in a weltering sea of sensibility and emotion, but who never does a manly concrete deed."—James, "Psychology," Vol. I., p. 125.

"Education must seek to develop social action. It can take no account of possible thought or feeling which exercises no influence upon one's behavior. . . . The school can not have for its leading principle the improvement of the individual as an isolated being."—O'Shea, "Education as Adjustment," p. 95.

"Education for culture alone tends to isolate the individual; education for sympathy with one's environment tends to make the individual an integral part of the activities and progress of his time."—Bailey, "The Nature-study Idea," p. 63.

[30] "The interests of higher education will be better served by such prescription of college entrance requirements, and such tests of preparation, as will do most to vitalize instruction in the secondary schools."—Brown, "The Making of Our Middle Schools," p. 443.

THE LAWS OF ENVIRONMENTAL INFLUENCE

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THE relation of environment to heredity presents an issue that is becoming increasingly clear. I will state it in the words of Dr. F. A. Woods. "Experimentally and statistically, there is not a grain of proof that ordinarily environment can alter the *salient mental and moral traits* in any measurable degree from what they were predetermined to be through innate influences."[1] The premises of this statement lie in biology, while the conclusions must be verified by facts in social science. Dr. Woods implies that, for each virtue society holds dear and for each vice it condemns, there is a biologic character without the presence of which the virtue or the vice could not appear. This position controverts the evidence of social science as to the basis on which virtues and vices rest.

To discuss this problem, I must begin with the difference between the data of social and biologic sciences. Biology uses experiment and hence begins with germ cells: social science is based on observation and hence its data are the visible differences which the study of men affords. Both call their data characters, but as a loose terminology creates confusion, I shall call the germinal variations the biologist finds through experiment *characters,* while the visible differences in men open to observation I shall call *traits.* The problem then is what is the relation of biologic characters to visible traits? Is there a character for each trait, or do independent laws govern traits? To answer these questions, traits must be divided into two classes; mental traits are measured by differences in thought and expression while bodily traits denote external differences. Mental traits are again divided into social traits, which are impressed on individuals by society and physical traits which reflect brain activity.

Physical traits do not correspond to the virtues and vices emphasized by society. There are only five that have social significance—imitation, suggestion, sympathy, self-interest and will power. These have biologic antecedents. Social traits, however, change from environment to environment, from group to group and even from family to family. They are readily adopted, easily lost and have the marks of acquired characters. The motives for adopting a virtue come to the individual through social influences. The power in him leading to its acceptance is not due to some unit-character corresponding to the virtue in question,

[1] The Popular Science Monthly, April, 1910.

but is the result of will power exercised in this particular direction. An abstainer from alcoholic drinks has no unit-character distinguishing him from those who drink. He uses his will power to create an ideal of abstinence from which habits grow up, making it easy for him to reject liquor. His son, however, will have to go through the same process; nor is the effect diminished unless the temptation is reduced by the absence of opportunity. Bravery, honor, chastity, thrift, honesty and a host of other virtues are in the same position. They are due to one power manifested in many ways and not to many innate characters each manifested in one way. Can any one pick out the psychic or physical mark that accompanies these virtues? If not, it is more reasonable to assume that the virtues a man cherishes are due to the society of which he is a part and not to the germinal determinants that make up his heredity. The real difference between a virtuous person and a victim of vice is that the one has will power to resist temptation while the other lacks will power. The drunkard did not mean to become a drunkard, nor did anything in his make-up force him to become one. He merely wanted to enjoy himself and failed to exercise his will power in restraint of temptation. The same is true of the prostitute. There is no race trait separating her from other women. Lacking home restraints, she drifted into vice, with the result that she was excluded from all social relations except those of her occupation. Vice is not a physical abnormality, but the lack of will power or of a restrictive social environment. The negative of each virtue is a vice, and it appears when the contrasted virtue is not evoked. Both are social in origin and in neither case are there special unit characters except those involved in the expression of will power. A single determinant coupled with a favorable environment gives reality to all the virtues. The lack of will power plus temptation is vice; the growth of will power minus temptation is virtue. These two forces make the difference that exists between the good and the bad.

Criminal traits differ from virtues and vices in that they have a physical background. The study of degeneration carried on by Lombroso and his disciples shows that they are biologic characters. They represent, however, reversions and not creations. They are thus due not to alterations in the germ cell by which it gets more or different determinants, but to retardations in development by which a full expression of inherited traits is prevented. The criminal has had his growth checked, so that he expresses not the full power of his race, but the traits of this race at some earlier period. To hate, to envy, to be brutal are atavistic traits natural to his ancestors, but now suppressed by the full development of normal powers. Their sources are therefore the sources of retardation; they must be studied as examples of retardation and not of germ cell development.

The environment of a man changes not as he moves from place to place, but as his income is raised or lowered. A change from $10 to $20 a week alters radically the conditions under which a family lives and gives to its members other motives and temptations than those that moved them in their earlier period. Two contrasted conditions result. A condition of surplus where choices are large and a condition of deficit where physical wants are seldom met. Each of these states have visible effects that can be readily traced. A state of deficit affecting children results in defective bodily development. The child matures more rapidly and loses the plasticity of mind and body which better nourished children possess. This means the appearance of atavistic traits which in turn promote criminal tendencies. A state of deficit is thus the cause of crime and of those peculiarities that accompany the retardation of development. Families under its influence falling below the normal standard approximate in thought and character the condition of distant ancestors. Deficit and retardation are different phases of one group of tendencies. Deficit is the cause; retardation is an effect. The result is the increase of crime and the loss of moral tone.

The deterioration due to a deficit is not more marked than that due to a surplus. An animal eats freely and even gorges itself without injury because the energy to acquire food must always be kept active in order to assure survival. Men, however, separate action from enjoyment; those who are favored in income can expand their consumption without correspondingly increasing their activity. The constant stimulation of appetite and the overworking of organs to relieve the system of its load leads to morbidness and disease. It also results in the creation of toxic substances which poison the body and depress mental activity. These evils react on the will and reduce its power to control thought and activity. With the decay of will power the moral virtues are undermined. The victim of indulgence thus sinks into vice and drifts into evils that an active will power would have avoided. Morbidness, disease, auto-intoxication, a weak will and vicious inclinations appear when social conditions throw into the hands of individuals a surplus that permits a cessation of strenuous activity.

Surplus and deficit are thus equally dangerous. Those in want have their development retarded and suffer from the evils bound up with this condition. Those whose surplus permits satiety and idleness suffer with equal severity from a train of evils that flows from morbid conditions. Moral, vicious and criminal traits thus vary with objective conditions and are marks of bodily states that depend on the surplus and deficit of society. The result is the sinking of the race into a subnormal condition from which there is no relief until economic conditions are altered. Normality is increased by taking from the surplus of the prosperous and adding to the welfare of those injured by poverty.

It is not increased by an elimination which merely changes the character of defects without reducing their amount. Vices are the negative of will power: criminal traits are the negative of development. They are not independent characters corresponding to changes in the germ cell.

The main result of the preceding discussion is to show that the unit-characters of the germ-cell do not correspond to the moral and immoral traits made emphatic in social science. The biologic characters important in social science are few in number, of which will power is the only one on which the present progress of the race depends. Social traits correspond to the peculiar conditions in which society finds itself and they grow in number as the complexity of the environment increases. Chastity, thrift or temperance indicates desirable social conditions which are pictured in the ideal they create. There could be forty such characters with no biologic change except a growth of will power. Progress in man is due to concentration of energy. The central organs, the brain and its adjuncts, have grown at the expense of the terminal organs such as the hand, foot, teeth and jaw. More energy goes to the brain and less to the external structures of vital importance to lower animals. This concentration of energy results in the prolongation of childhood, the growth of psychic powers and the dominance of will over instinct. But at the same time it creates a deficit in terminal organs which forces them into a state of decay. The marks of these changes are the psychic effects revealed in thought and the regressive effects seen in terminal organs. A single biologic tendency could thus create all the difference that separates man from other animals.

We are now in a position to discuss the variations that create differences between parent and child. One source of difference is degeneration, caused by a surplus of nutriment. This clogs the system, produces morbidness and creates auto-intoxication. The final mark is a weak will. The lack of central control is prominent in degeneration and leads to many manifestations of which hysteria is an example. A second difference of parent and child is due to retardation. Each organism in its development repeats the history of its ancestors. An imperfect recapitulation means that the growth of the child stops short of the development of the normal ancestor. From this source many variations arise. A third difference between parent and child is caused by regression. As distinguished from degeneration and retardation, regression is only partial indicating real progression in unobserved parts. In man the terminal organs fail to come up to the standard set by earlier development. The central organs, however, are progressive and their growth is the real cause of the regression of terminal organs.

No terminal organ will attain its full development except under the stimulus of constant use. In a blacksmith's arm the stimulus causing its growth is in his mind and not in his arm. He wants certain goods and the way to get them is to use his arm as a smith. The positive side of his development is psychic through which a greater appreciation of goods arises. This leads to work; work involves exercise and exercise leads to growth of the arm. In the case of a musician the stimulus that develops the hand is in his appreciation of music. So long as the love of music persists the stimulus is present which arouses the peculiar growth in the arm. Instead therefore of a new modification in the germ cell being needed to perpetuate the modification of the musician's arm the germ-cell modification has already been made. It exists in the psychic variation creating the love of music. While this persists, the stimulus is present that forces the right growth in the arm. The arm of the musician as compared with that of a laborer is regressive but the stimulus that comes from a love of music keeps active a group of muscles and leads to their growth. There is a general terminal regression counteracted in specific cases by the stimulus due to the activity of central organs. This, I believe, will be found true of all cases purely regressive. They are the effects of progressive changes in the central organs. They should not be confused with degeneration and retardation which indicate a real backward movement.

The other ways in which parent and child differ are through injury and recovery. Any child may be injured in ways that will affect subsequent growth. So in turn he may be free from injuries of parents or, what is more important, his environment may be so modified that injuries to which they were subjected become less frequent or disappear. Ancestors may suffer injury from a disease like malaria or from a parasite like the hook worm for so long a time that the injury seems inherited. A change of environment, however, may prevent the injury and bring back the children to normal standards. Recoveries of this sort are as frequent as the injuries that depress; they need recognition in any scheme to present the differences between parent and child.

It may seem from the last paragraphs that I am getting over into biology where other persons are a better judge of the facts than I am. The change of attitude is, however, more apparent than real. The traits of men and the facts about degeneration were observed long before biology became a science. What biology has done is not to discover new traits, but to enable us to classify them and to show their causes. Only the most obvious facts of biology are needed for this purpose, and they are of importance not to help observation, but to point out remedies. That riches caused men to degenerate and that poverty retards the development of the poor are well-established facts.

They show that states of surplus and deficit affect not only moral traits but also create degeneration and retardation. Psychology, however, has added a clearly defined cause of non-development which had escaped notice. The growth of an organ depends partly on the direction given to growth by the unit characters of the germ-cell and partly to the use to which it is put. Even if the forces of the germ-cell are normal no organ will fully develop without constant exercise. Regression in an organ will take place if the stimuli to exercise are absent. These stimuli lie not in the organ, but in the brain cells. Mental activity may fail from three causes. Psychic traits may be inactive through degeneration: they may not develop because of retardation: or the environment may lack the elements that arouse their activity. In each of these cases the trouble lies in objective facts mainly if not solely of an economic nature. Regressions do not differ in their origin from degenerations and retardations. They all arise from defects in the environment and thus do not indicate changes in the unit-characters of the germ-cell.

A study of man should begin with his social nature and with the degenerate forces at work within him. These two problems run into each other because it is man's social nature that has stopped elimination. Society uses its nurture to keep the weak alive and hence improved conditions means not progress but degeneration. A second difference between men and animals arises out of the social classes which differences in income create. The poor are in this way subject to exploitation and held in the grip of want. Dr. Woods says men have choices and can escape their environment. This is in a degree true of the higher income levels but not of the poor. Their fate is as definite and as objective as that of any lower animal. Along with poverty goes physical retardation, and the two combined are responsible for the mass of traits associated with the poor. A full maturity depends on the stimuli that evoke activity and hence promote growth. These stimuli are psychic traits made active in men by contact with the economic environment. This means that wealth is needed to place around each family the proper objects to excite interest: without them the psychic powers are dormant and the physical are regressive.

The environment of a man is determined not by his geographical habitat, but by his income. The various income levels of society create as marked differences in men as differences in latitude do in animals. The influence of environment on man is therefore not less but different from the same influence on animals. All virtues and defects in men are environmental. The virtues are social; the defects are degenerations, retardations and regressions. Most observable traits come under these heads. They change with the environment and not with the germ cell. Only those changes that are really progressive can be

attributed to the germ-cell. All other traits can be traced directly or indirectly to social or nutritive alterations. Heredity is the one power that can transform man into a superman and we must rely on it to reach this higher level. The actual problems we face to-day are those of degeneration. We must get rid of the subman before we can rise to the superman's level. The subman is made by environment as truly as the superman will be made by heredity. We must therefore act through objective agencies until the normal in men has been evoked. Are social traits acquired or natural? Is degeneration in man due to bad environment or to heredity? These are the problems which must be fairly faced and definitely solved before it can be justly claimed that man is freer from environmental control than are the lower forms of animal life.

THE RACE FIBER OF THE CHINESE

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OUT of ten children born among us three, normally the weakest three, will fail to grow up. Out of ten children born in China these weakest three will die and probably five more besides. The difference is owing to the hardships that infant life meets with among the Chinese. If at birth the white infants and the yellow infants are equal in stamina, the two surviving Chinese ought to possess greater vitality of constitution than the seven surviving whites. For of these seven the five that would infallibly have perished under oriental conditions of life are presumably weaker in constitution than the two who could have endured even such conditions. The two Chinese survivors will transmit some of their superior vitality to their offspring; and these in turn will be subject to the same sifting and the surviving two tenths will pass on to *their* children a still greater vitality. So that these divergent child mortalities drive, as it were, a wedge between the physiques of the two races. If, now, for generations we whites, owing to room and plenty and scientific medicine and knowledge of hygiene have been subject to a less searching and relentless elimination of the weaker than the Chinese, it would be reasonable to expect the Chinese to exhibit a greater vitality than the whites.

With a view to ascertaining whether the marked slackening in our struggle for life during the last century or two and our greater skill in keeping people alive has produced noticeable effects on our physique, I closely questioned thirty-three physicians practising in various parts of China, usually at mission hospitals.

Of these physicians, only one, a very intelligent German doctor at Tsing tao, had noticed no point of superiority in his Chinese patients. He declared them less enduring of injury, less responsive to treatment and no more enduring of pain than the simple and hardy peasants of Thuringia amongst whom he had formerly practised. Three other physicians, each of whom had practised a quarter century or more in China, had observed no difference in the physical reactions of the two races. I fancy their recollections of their brief student practise at home had so faded with time that they lacked one of the terms of the comparison. Moreover, two of these admitted under questioning that the Chinese *do* stand high fevers remarkably well and that they *do* recover from blood poisoning when a white man would die.

The remaining twenty-nine physicians were positive that the

Chinese physique evinces some superiority or other over that of their home people. As regards surgical cases, the general opinion is voiced by one English surgeon, who said, "They do pull through jolly well!" It was commonly observed that surgical shock is rare, and that the proportion of recoveries from serious cuttings is as high in the little poorly equipped, semi-aseptic mission hospitals of China as in the perfectly appointed, aseptic hospitals at home. Dr. Kinnear, of Foochow, recently home from a furlough in Germany, found that in treating phlegma of the hand he with his poor equipment and native assistants gets as good results as the great von Bergman working under ideal conditions on the artisan population of Berlin. The opinion prevails that under equal conditions the Chinese will make a surer and quicker recovery from a major operation than the white.

Many never get over being astonished at the recovery of the Chinese from terrible injuries. I was told of a coolie who had his abdomen torn open in an accident, and who was assisted to a hospital supported by a man on either side and holding his bowels in his hands. He was sewed up and in spite of the contamination that must have gotten into the abdomen, made a quick recovery. Amazing also is the response to the treatment of neglected wounds. A boy whose severed fingers had been hastily stuck on any how and bound up with dirty rags came to the hospital after a week with a horrible hand and showing clear symptoms of lockjaw. They washed his hand and sent him home to die. In three days he was about without a sign of lockjaw. A man whose fingers had been crushed under a cart some days before came in with blood poisoning all up his arm and in the glands under the arm. The trouble vanished under simple treatment. A patient will be brought in with a high fever from a wound of several days standing full of maggots; yet after the wound is cleaned the fever quickly subsides. A woman who had undergone a serious operation for cancer of the breast suffered infection and had a fever of 106°, during which her husband fed her with hard water chestnuts. Nevertheless, she recovered.

Nearly all are struck by the resistance of the Chinese to blood poisoning. From my note books I gather such expressions as "Blood poisoning very rare. More resistant than we are to septicæmia." "Relative immunity to pus-producing germs." "More resistant to gangrene than we are. Injuries which at home would cause serious gangrene do not do so here." "Peculiarly resistant to infection." "With badly gangrened wounds in the extremities show very little fever and quickly get well." "Women withstand septicæmia in maternity cases wonderfully well, recovering after the doctors have given them up." "Recover from septicæmia after a week of high fever that would kill a white man." No wonder there is a saying rife among the foreign doctors, "Don't give up a Chinaman till he's dead."

In the south where foot binding is not prevalent the women bear their children very easily, with little outcry, and are expected to be up in a day or two. Dr. Swan, of Canton, testifies that more than once on calling for a sampan to take him across the river he has been asked to wait a quarter or a half hour. By that time the mistress of the boat would have given birth to the child, laid it in a corner among some rags and be ready to row him across. In childbirth the woman attended by a dirty old mid-wife in a filthy hovel escapes puerperal fever under conditions that would certainly kill a white woman. In cases of difficult birth when after a couple of days the white physician is called in and removes the dead infant, the woman has some fever but soon recovers. The women, moreover, are remarkably free from displacements and other troubles peculiar to the sex.

Living in a super-saturated, man-stifled land, profoundly ignorant of the principles of hygiene, the masses have developed an immunity to noxious microbes which excites the wonder and envy of the foreigner. They are not affected by a mosquito bite that will raise a large lump on the lately come foreigner. They can use contaminated water from canals without incurring dysentery. There is very little typhoid and what there is is so attenuated that it was long doubted to be typhoid. The fact was settled affirmatively only by laboratory tests. All physicians agree that among the Chinese smallpox is a mild disease. One likened it to the mumps. Organic heart trouble, usually the result of rheumatic faver, is declared to be very rare.

It is universally remarked that in taking chloroform the Chinese rarely pass through an excited stage, but go off very quietly. From after nausea they are almost wholly free. One physician of twenty-five years' practise has never had a death from chloroform, although he has not administered ether half a dozen times. The fact is, however, they stolidly endure operations which we would never perform without an anesthetic. Small tumors are usually thus removed and in extracting teeth gas is never administered. Sometimes extensive cutting—*e. g.*, the removal of a tumor reaching down into and involving the excision of the decayed end of a rib—is borne without flinching. Only three physicians interviewed had failed to remark the insensibility of their patients to pain. Here, perhaps, is the reason why no people in the world have used torture so freely as the Chinese. This bluntness of nerve, however, does not appear to be universal. The scholars, who usually neglect to balance their intense brain work with due physical exercise, are not stoical. The meat-eating and wine-bibbing classes lack the insensibility of the vegetarian, non-alcoholic masses. The self-indulgent gentry who shun all activity, bodily or mental, and give themselves up to sensual gratification, are very sensitive to pain and very fearful of it. Some make the point, therefore, that the oft-noted dull-

ness of sensibility is not a race trait, but a consequence of the involuntary simplicity and temperateness of life of the common Chinese.

One doctor remarks that at home it is the regular thing for a nervous chill to follow the passing of a sound into the bladder, whereas among his patients it seldom occurs. Another comments on the rarity of neurasthenia and nervous dyspepsia. The chief of the army medical staff points out that during the autumn maneuvers the soldiers sleep on damp ground with a little straw under them without any ill effects. I have seen coolies after two hours of burden-bearing at a dog trot shovel themselves full of hot rice with scarcely any mastication, and hurry on for another two hours. A white man would have writhed with indigestion. The Chinese seem able to sleep in any position. I have seen them sleeping on piles of bricks, or stones, or poles, with a block or a brick for a pillow and with the hot sun shining full into the face. They stand a cramped position longer than we can and can keep on longer at monotonous toil unrelieved by change or break.

But there is another side to the comparison. There is little pneumonia among the Chinese but they stand it no better than we do, some say not so well. There is much malarial fever and it goes hard with them. In Hong Kong they seem to succumb to the plague more readily than the foreigners. Among children there is heavy mortality from measles and scarlet fever. In withstanding tuberculosis they have no advantage over us. While they make wonderful recoveries from high fevers they are not enduring of long fevers. Some think this is because the flame of their vitality has been turned low by unsanitary living. They have a horror of fresh air and shut it out of the sleeping apartment, even on a warm night. In the mission schools, if the teachers insist on open windows in the dormitory, the pupils stifle under the covers lest the evil spirits flying about at night should get at them. The Chinese grant that hygiene may be all very well for these weakly foreigners, but see no use in it for themselves. It is no wonder, therefore, that their school girls can not stand the pace of American school girls. Often they break down, or go into a decline or have to take a long rest. In the English mission schools with their easier pace the girls get on better.

Here and there a doctor ascribes the extraordinary power of resistance and recuperation shown by his patients entirely to their diet and manner of life and denies any superior vitality in the race. Other doctors practising among the city Chinese insist that the stamina of the masses is undermined by wretched living conditions, but that under equal circumstances the yellow man has a firmer hold on life than the white man.

From the testimony it is safe to conclude that at least a part of the observed toughness of the Chinese is attributable to a special race vital-

ity which they have acquired in the course of a longer and severer elimination of the less fit than our North-European ancestors ever experienced in their civilized state. Such selection has tended to foster not so much bodily strength or energy as recuperative power, resistance to infection and tolerance of unwholesome conditions of living. For many centuries the people of south and central China, crowded together in their villages or walled cities, have used water from contaminated canals or from the drainings of the rice fields, eaten of the scavenging pig or of vegetables stimulated by the contents of the cesspool, huddled under low roofs, on dirt floors, in filthy lanes, and slept in fetid dens and stifling cubicles. Myriads succumb to the poisons generated by overcrowding and hardly a quarter of those born live to transmit their immunity to their children. The surviving fittest has been the type able to withstand foul air, stench, fatigue toxin, dampness, bad food and noxious germs. I have no doubt that if an American population of equal size lived in Amoy or Soochow as the Chinese there live, a quarter would be dead by the end of the first summer. But the toughening takes place to the detriment of bodily growth and strength. Chinese children are small for their age. At birth the infants are no stronger than ours. The weaker are more thoroughly weeded out, but even the surviving remnant are for a time weakened by the hardships that have killed the rest.

I would not identify the great vitality of the Chinese with the primitive vitality you find in Bedouins, or Sea Dyaks, or American Indians. This early endowment consists in unusual muscular strength and endurance, in normality of bodily functions, and in power to bear hardship and exposure. It does not extend to immunity from disease. Subjected to the conditions the civilized man lives under savages die off like flies. The diseases that the colonizing European communicates to nature men clears them away more swiftly than his gunpowder. Entrance upon the civilized state entails a universal exchange of disease germs and the necessary growth of immunity. Now, it is precisely in his power to withstand the poisons with which close-dwellers infect one another that the Chinaman is unique. This power does not seem to be a heritage from his nomad life of five or six thousand years ago. It is rather the painful acquisition of a later social phase. It could have grown up only in congested cities, or under an agriculture that contaminates every growing plant, converts every stream into an open sewer, and fills the land with mosquito-breeding rice fields. Such toleration of pathogenic microbes has, perhaps, never before been developed and it certainly will never be developed again. Now that man knows how to clear away from his path these invisible enemies, he will never consent to buy immunity at the old cruel price.

To the west the toughness of the Chinese physique may have a sin-

ister military significance. Nobody fears lest in a stand-up fight Chinese troops could whip an equal number of well-conditioned white troops. But few battles are fought by men fresh from tent and mess. In the course of a prolonged campaign involving irregular provisioning, bad drinking water, lying out, loss of sleep, exhausting marches, exposure, excitement and anxiety, it may be that the white soldiers would be worn down worse than the yellow soldiers. In that case the hardier men with less of the martial spirit might in the closing grapple beat the better fighters with the less endurance.

In view of what has been shown the competition of white laborers and yellow is not so simple a test of human worth as some may imagine. Under good conditions the white man can best the yellow man in turning off work. But under bad conditions the yellow man can best the white man, because he can better endure spoiled food, poor clothing, foul air, noise, heat, dirt, discomfort and microbes. Reilly can *outdo* Ah San, but Ah San can *underlive* Reilly. Ah San can not take away Reilly's job as being a better workman; but, because he can live and do some work at a wage on which Reilly can not keep himself fit to work at all, three or four Ah Sans can take Reilly's job from him. And they will do it too, unless they are barred out of the market where Reilly is selling his labor. Reilly's endeavor to exclude Ah San from his labor market is not the case of a man dreading to pit himself on equal terms against a better man. Indeed, it is not quite so simple and selfish and narrow-minded as all that. It is a case of a man fitted to get the most out of good conditions refusing to yield his place to a weaker man able to withstand bad conditions.

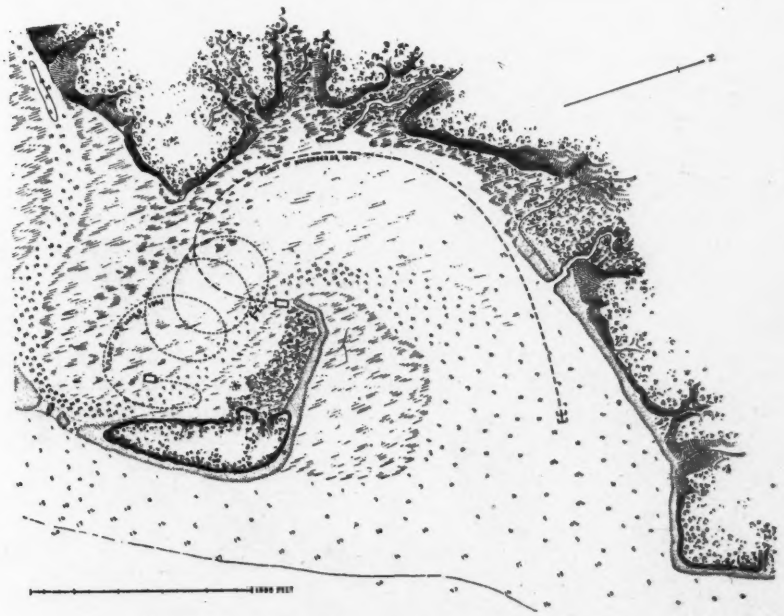
Of course, with the coming in of western sanitation, the terrible selective process by which Chinese toughness has been built up will come to an end, and this property will gradually fade out of the race physique. But for our time at least it is a serious and pregnant fact. It will take some generations of exposure to the relaxing effects of drains, ventilation, doctors, district nurses, food inspectors, pure water, open spaces and out-of-door sports to eradicate the peculiar vitality which the yellow race has acquired. During the interim the chief effect of freely admitting coolies to the labor markets of the west would be the substitution of low wages, bad living conditions and the increase of the yellow race for high wages, good living conditions and the increase of the white race.

THE PROGRESS OF SCIENCE

LANGLEY MEMOIR ON MECHANICAL FLIGHT

In the development of mechanical flight the United States has taken an honorable place both in theory and in practise. The work of Langley, Chanute and the Wright brothers can not be paralleled by any other nation. While in many directions we have done more than our share in mechanical invention, it has often happened that we have depended on Great Britain, France and Germany for scientific principles. But Langley was an eminent physicist and Chanute a leading engineer. It is interesting to know how far their achievements in aeronautics were based on mathematics and physical research and how far on empirical trials. The Langley "Memoir on Mechanical Flight," just published by the Smithsonian Institution, gives full details in regard to the work done by Langley and under his direction. The first part of the volume was in the main written by him in 1897; the second part, dealing with further experiments with the small models and with the large aerodrome, has been written by Mr. Charles M. Manly, who became assistant in charge of the experiments in 1898.

In 1891 Langley announced as the result of experiments carried on through previous years that machines could be constructed which would give such a velocity to inclined surfaces that bodies indefinitely heavier than the air could be sustained upon it and moved through it at a great speed. As a result of experiment and theory it was proved that one-horse power



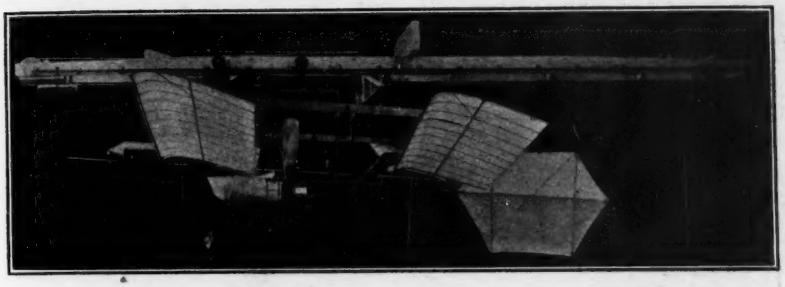
PATH OF AERODROME FLIGHTS, MAY 6 AND NOVEMBER 28, 1896, NEAR QUANTICO, VA., ON THE POTOMAC RIVER.

AERODROME IN THE AIR DURING ITS FLIGHT ON MAY 6, 1896.

would propel and sustain in horizontal flight at a velocity of about forty miles an hour a little over 200 pounds. Langley's experiments were in the main made with a whirling-table which forces the model to move in horizontal flight and at a fixed angle. In 1887, however, he began experiments with free-flying models at the Allegheny Observatory, following Pinaud in using twisted rubber as motive power. Some forty models were made, but while, as Pinaud had shown, a small toy could be made to fly for a few seconds, the motive power was inadequate for a larger machine or a longer flight.

In 1891 Langley began the construction of a steam engine. Daimler had invented the internal-combustion engine in 1885, but its possibilities were not at first realized, and it was necessary to wait for the development of the automobile to demonstrate the remarkable combination of power and lightness in an engine which has made possible the contemporary aeroplane. After innumerable experiments a steam engine was constructed weighing about six pounds and of approximately one-horse power. An aerodrome, chiefly of steel, weighing, apart from fuel and water, about twenty-four pounds, was launched on the Potomac River on May 6, 1896, and flew for over half a mile. It alighted with safety and performed a second flight on the same day. This was a performance of great historic interest. The paths of the aerodrome on May 6 and again on November 28 are here reproduced, as also an instantaneous photograph of the aerodrome in the air, which bears a remarkable resemblance to a contemporary picture.

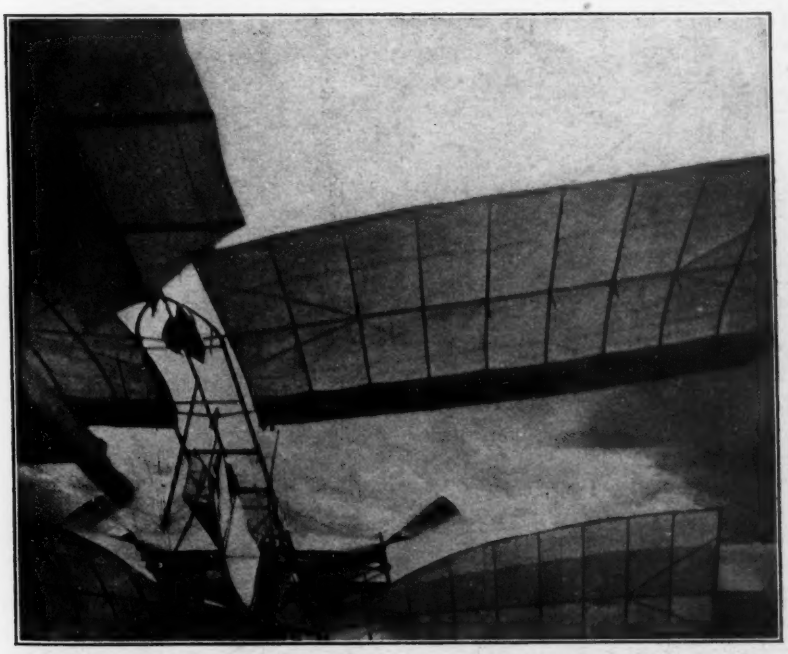
In 1898 the board of ordnance and fortifications of the war department appropriated $50,000 for experiments with a man-carrying aerodrome. Langley was at first indisposed to complete the work which he had carried so far, believing that might be left to commercial enterprise. It was, however, undertaken with the assistance of Mr. Manly, who now describes the results in this memoir. The great difficulty, as before, was with the engine. A New York builder could not supply the



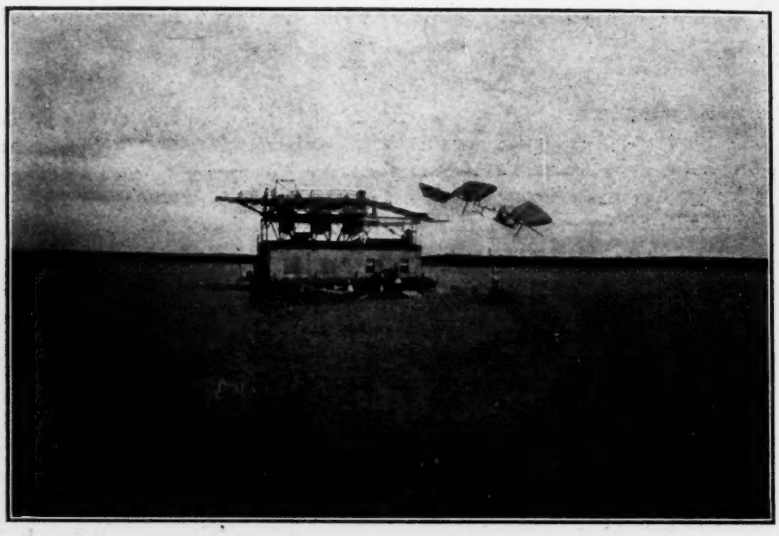
AERODROME NO. 5 ON LAUNCHING-WAYS.

gasoline engine for which he had contracted; no European builder thought it possible to supply a twelve-horse power engine weighing as little as 200 pounds. Mr. Manly at the end of the year 1901 had succeeded in constructing an engine of fifty-horse power, weighing about 200 pounds.

After long-continued experiments in adjusting the engine, the aerodrome was made ready for trial. The house-boat and launching gear caused innumerable difficulties but on October 7, 1903, at 12.20 P.M. the aerodrome, with Mr. Manly in control, was launched. The trial ended disastrously, owing to an accident by which a guy-post caught in the launching gear. Mr. Manly narrowly escaped drowning through entanglement in the wrecked machine. He showed great courage in again repeating the experiment under unfavorable conditions on December 8, when again the launching gear was at fault, and the aerodrome had no opportunity to demonstrate its power of flight. Owing mainly to ridicule in the newspapers and the fear of its effect on



FLIGHT OF LARGE AERODROME, OCTOBER 7, 1903.



FLIGHT OF LARGE AERODROME, OCTOBER 7, 1903.

Congress the army board was unwilling to continue the work. In the meanwhile the Wright brothers had begun their experiments with flying machines and in the year of the trial of the Langley aerodrome accomplished their first flight with a motor. In 1905 they remained in the air for half an hour, but it was not until 1908 that they fully demonstrated the practicability of sustained flight. Langley died on February 27, 1906, at the beginning of the era of mechanical flight to which his researches had so largely contributed.

THE ADDRESS OF THE PRESIDENT OF THE BRITISH ASSOCIATION

SIR WILLIAM RAMSAY presided over the recent meeting of the British Association for the Advancement of Science at Portsmouth, and, like many of his predecessors in the chair, made an address that is of very general interest. He gave a clear account of ancient and modern views regarding the chemical elements, laying, as is natural, much stress on the new discoveries in which he himself has taken such a leading part. It is not possible to review the marvelous story of the recent developments of chemistry more concisely than is done in the addr ss. It is of interest to note that Sir William Ramsay maintains, though rather incidentally, the validity of his experiments from which he concluded that the metal copper is converted partially into lithium by the energy radiated from radium, and that thorium, zirconium, titanium and silicon are degraded into carbon. It will be remembered that Madame Curie was unable to confirm these results.

Sir William Ramsay passes from the disintegration of the atom to the question of the available supply of energy, especially for Great Britain. He tells us that each Greek freeman had five helots who did his bidding, saving him from manual labor and giving Athens its preeminence in literature and thought, but that people in Great Britain are still better off, each family having twenty helots represented by the consumption of fifty million tons of coal annually. It is this coal which has given England its great wealth and commercial supremacy. At the present rate of increase of consumption the supply will be exhausted within 175 years, and there appears to be nothing

MEMORIAL TO COLUMBUS ERECTED IN THE UNION STATION AT WASHINGTON, D. C.

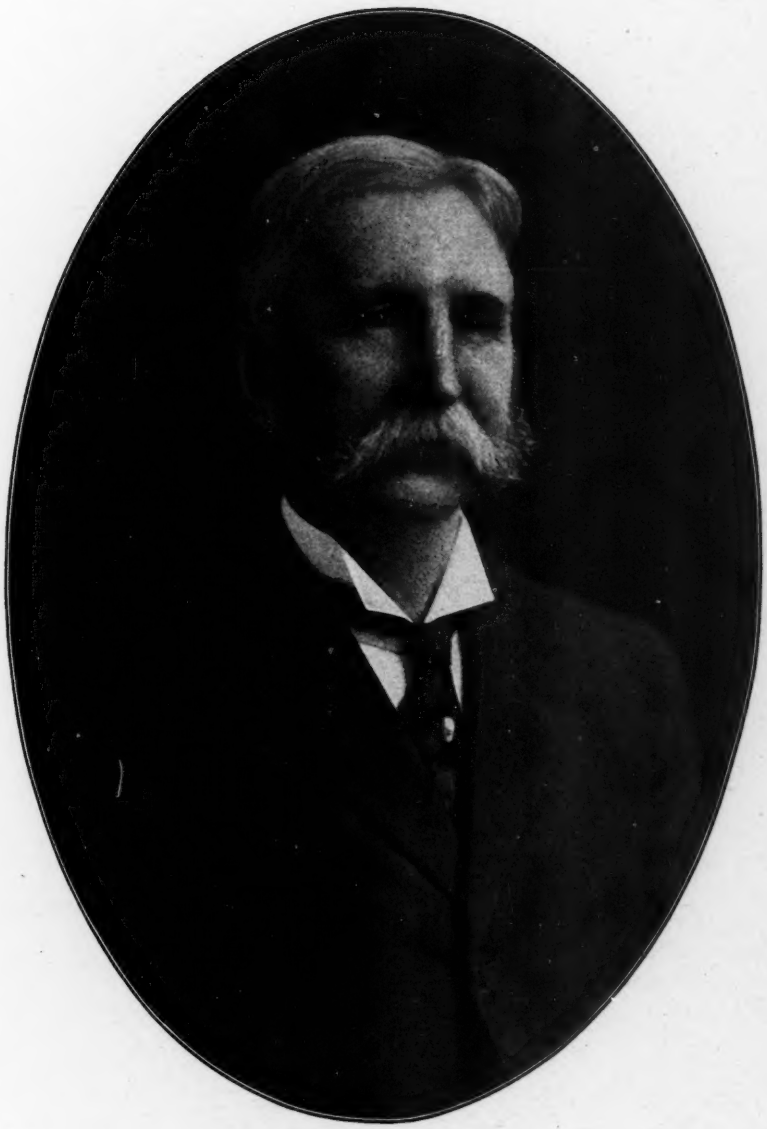
to take its place. The best advice that Sir William Ramsay can give is to use it economically. He, however, calls attention to the forestry systems of Germany and France, and the efforts in this country on behalf of conservation. He reminds us of the enormous quantity of energy stored up in radium and its constituents. If the energy of a ton of radium could be utilized in thirty years, instead of being evolved at its invariable slow rate of 1,760 years for half-disintegration, it would suffice to propel a ship of 15,000 tons, with engines of 15,000 horse power, at the rate of 15 knots an hour, for 30 years—practically the lifetime of the ship. To do this actually requires a million and a half tons of coal. We are told, however, that the production of radium will never surpass half an ounce a year. If, however, the elements which we have been used to regard as permanent are capable of changing with evolution of energy, and if some form of catalyzer could be discovered which would increase their slow rate of change, then a boundless supply of energy would be available for the human race. Sir William Ramsay says that it would be folly to consider seriously a possible supply of energy in an acceleration of the liberation of energy by atomic change; but he concludes the address with the remark that while radioactive substances are in all probability incapable of industrial application, apart from medicine, their study has shown us to what enormous advances in the concentration of energy it is permissible to look forward, with the hope of applying the knowledge thereby gained to the betterment of the human race.

THE DIRECTOR OF THE AMERICAN MUSEUM OF NATURAL HISTORY

Dr. Frederic A. Lucas, recently appointed director of the American Museum of Natural History, was born in Plymouth, Mass., in 1852. At the age of nineteen he entered Ward's Natural Science Establishment, a commercial museum for the preparation of natural history objects of all kinds. Here he acquired his first practical training in the preparation of natural history specimens, including the mounting of birds, mammals and other vertebrates, the preparation and mounting of skeletons and casts of fossils, and in time he became manager of the establishment. During his connection with the famous Rochester institution two of his colleagues were William T. Hornaday and Charles H. Townsend, and it is noteworthy that these three men who were working together thirty-one years ago should one after another have been called to direct the work of three of the most important institutions of the kind in this country if not in the world —the American Museum of Natural History, the New York Zoological Park and the Aquarium.

In March, 1882, Dr. Lucas was called to the United States National Museum as osteologist. He is to be credited with the assembling, preparation, mounting, classifying and labeling of the fine osteological hall of the National Museum. He was gradually promoted until in 1902 he was placed in charge of all the exhibits of the department of biology.

His admirable work in the National Museum and long experience in museum methods of preparation and exhibition, as well as his growing reputation as an investigator and writer, led to his selection as curator-in-chief of the Museum of the Brooklyn Institute of Arts and Sciences, where he had free play for his talents. Dr. Lucas's work in the Brooklyn Museum has been marked not only by great activity in the acquisition of specimens and collections but also by rare originality in the display of natural history objects, especially for the purpose of bringing out principles of zoology and classification in such a manner as to both attract and instruct all classes of visitors. He is practically the originator of the small but admirably arranged collection



DR. FREDERIC A. LUCAS,
Director of the American Museum of Natural History.

of vertebrates there, and no better nor more scientific installations of mammals are to be seen in any museum. The arrangement and labeling both from scientific and artistic standpoints are unique.

The especial purpose of the president and trustees of the American Museum of Natural History in the selection and appointment of Dr. Lucas as director is the advancement of the educational arrangement and exhibition of the vast collections which the museum has been acquiring from various parts of the world, especially during the past decade. In this field Dr. Lucas is recognized as the leading expert in this country. The trustees realize that the American Museum is very strong and well arranged in certain departments, while others lack sequence, and that either geographic, systematic or evolutionary sequence is necessary in order to give the collections their full educational value and effect.

SCIENTIFIC ITEMS

WE regret to record the deaths of Dr. Francis A. March, professor emeritus of comparative philology and English literature at Lafayette College, of Dr. Thomas Dwight, professor of anatomy at Harvard University, and of Professor Franklin H. King, of Madison, Wis., known for his publications on agriculture.

DR. E. A. SCHÄFER, professor of physiology at Edinburgh, has been elected president of the British Association, for the meeting to be held next year at Dundee, beginning on September 4. The meeting of 1913 will be held at Birmingham.

THE annual Herter lectures will be delivered at the Johns Hopkins University on October 4, 5 and 6, by Professor Dr. Albrecht Kossel, of the University of Heidelberg, who was awarded the Nobel prize last year for his discoveries in medical chemistry.

NEXT year the American Geographical Society celebrates its jubilee, and in connection with this event a transcontinental excursion for the purpose of geographical study is planned, under the leadership of Professor W. M. Davis. The start from New York, by special train, will take place some time in August, and the excursion will conclude in October, its duration being six or seven weeks.

THE South Australian Cabinet has decided to contribute £5,000 towards the cost of the Mawson Antarctic Expedition.